Work Zone Safety and Mobility Manual

MDOT Michigan Department of Transportation

www.michigan.gov/mdotworkzones

MICHIGAN DEPARTMENT OF TRANSPORTATION

WORK ZONE SAFETY AND MOBILITY MANUAL

Engineering Manual Preamble

This manual provides guidance to administrative, engineering, and technical staff. Engineering practice requires that professionals use a combination of technical skills and judgment in decision making. Engineering judgment is necessary to allow decisions to account for unique site-specific conditions and considerations to provide high quality products, within budget, and to protect the public health, safety, and welfare.

This manual provides the general operational guidelines; however, it is understood that adaptation, adjustments, and deviations are sometimes necessary. Innovation is a key foundational element to advance the state of engineering practice and develop more effective and efficient engineering solutions and materials. As such, it is essential that our engineering manuals provide a vehicle to promote, pilot, or implement technologies or practices that provide efficiencies and quality products, while maintaining the safety, health, and welfare of the public. It is expected when making significant or impactful deviations from the technical information from these guidance materials, that reasonable consultations with experts, technical committees, and/or policy setting bodies occur prior to actions within the timeframes allowed. It is also expected that these consultations will eliminate any potential conflicts of interest, perceived or otherwise. MDOT Leadership is committed to a culture of innovation to optimize engineering solutions.

The National Society of Professional Engineers Code of Ethics for Engineering is founded on six fundamental canons. Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform Services only in areas of their competence.
3. Issue public statement only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, reasonably, ethically and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

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ACRONYMS
(updated 1/20/2020)

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
ATSSA	American Traffic Safety Services Association
BTP	Bureau of Transportation Planning
BWBTOC	Blue Water Bridge Transportation Operations Center
CAADT	Commercial Annual Average Daily Traffic
CIA	Construction Influence Area
CPM	Capital Preventive Maintenance
CPS	Construction Permit System
CO3	Construction, Congestion, Cost Software
CS	Control Section
DHV	Design Hour Volume
DUI	Driving Under the Influence
FHWA	Federal Highway Administration
FUSP	Frequently Used Special Provisions
GVMC	Grand Valley Metropolitan Council
HAR	Highway Advisory Radio
HCM	Highway Capacity Manual
HOV	High Occupancy Vehicle
I / D	Incentive / Disincentive
IDR	Inspector's Daily Report
ITS	Intelligent Transportation System
LCCA	Life Cycle Cost Analysis
LOS	Level of Service
MDOT	Michigan Department of Transportation
MMUTCD	Michigan Manual of Uniform Traffic Control Devices
MOT	Maintenance of Traffic
MPH	Miles per Hour
MPO	Metropolitan Planning Organization
NTCIP	National Transportation Communications for ITS Protocol
PAP	Performance Assessment Plan
PCMS	Portable Changeable Message Sign
PIP	Public Information Plan
POB	Point of Beginning
POE	Point of Ending

PPS	Planning Division / Project Planning Section
PR	Physical Reference
PTR	Permanent Traffic Records
PTS	Portable Traffic Signal
RPA	Regional Planning Agencies
RITIS	Regional Integrated Transportation Information System
RTF	Rural Task Force
SEMGOC	Southeast Council of Governments
SEMTOC	Southeast Michigan Transportation Operations Center
SPRT	Statewide Peer Review Team
STOC	Statewide Transportation Operations Center
TAR	Traffic Analysis Request
TCDS	Traffic Count Data Base System
TDMS	Transportation Data Management System
TIM	Traffic Incident Management
TMA	Truck Mounted Attenuator
TMP	Transportation Management Plan
TMS	Transportation Management System
TOC	Traffic Operations Center
TRPM	Temporary Raised Pavement Markings
TCO	Temporary Traffic Control Order
TSC	Transportation Service Center
TSSAT	Traffic and Safety Statewide Alignment Team
TTC	Temporary Traffic Control
TTCP	Temporary Traffic Control Plan
V / C	Volume to Capacity Ratio
VPH	vehicles per hour
VPHPL	vehicles per hour per lane
WMTOC	West Michigan Transportation Operations Center
WZA	Work Zone Area
WZCZ	Work Zone Clear Zone
WZDE	Work Zone Delivery Engineer
WZTCP	Work Zone Traffic Control Plan
WZCPR	Work Zone Construction Peer Review
WZSM	Work Zone Safety and Mobility

CHAPTER 1

INTRODUCTION

The Michigan transportation system is critical to supporting a vibrant economy by moving traffic and freight safely and efficiently. Growing congestion on Michigan roads with an increased need to perform rehabilitation and reconstruction is resulting in complex challenges to maintain work zone safety and mobility.

1.01 PURPOSE

The Work Zone Safety and Mobility (WZSM) Rule outlined in federal regulation, 23 CFR 630 Subpart J, requires a policy for the systematic consideration and management of work zone impacts on all federal aid highway projects across all stages of project planning, development, construction and operations.

The WZSM Policy (Michigan Department of Transportation (MDOT) Guidance Document 10177, dated August 24, 2007) was established in accordance with the WZSM Rule outlined in 23 CFR 630 Subpart J, to improve safety and mobility in work zones by reducing congestion and traffic incidents. The policy is in agreement with, and does not supersede, State Transportation Commission Policy 10015, dated September 25, 1996.

The primary goals of the WZSM Rule and WZSM Policy are to reduce crashes and manage congestion due to work zones.

To accomplish these goals, a Transportation Management Plan (TMP) is necessary for consistent consideration of the safety and mobility impacts of work zones, and the development of strategies and plans to reduce work zone impacts on all projects.

A TMP is a dynamic document that provides strategies, elements, and details for managing WZSM impacts during construction, maintenance, permits, and local agency work zones. The TMP is updated and revised throughout the life of the project.

MDOT is committed to providing work zones with the highest level of safety and mobility possible, beginning with project planning and extending through construction and operations. Management and staff are responsible for ensuring the policy is implemented and sustained for safe and efficient travel throughout the State of Michigan.

The specific processes, procedures, and guidelines to support the implementation of the policy are developed and communicated herein. This manual also includes methods for the analysis of crash data, mobility analysis, and work zone process review procedures.

Variations from the policy and this manual may be considered, evaluated, and incorporated into specific projects on a case-by-case basis. Contact the Work Zone Delivery Engineer (WZDE) to determine if a variation may be acceptable.

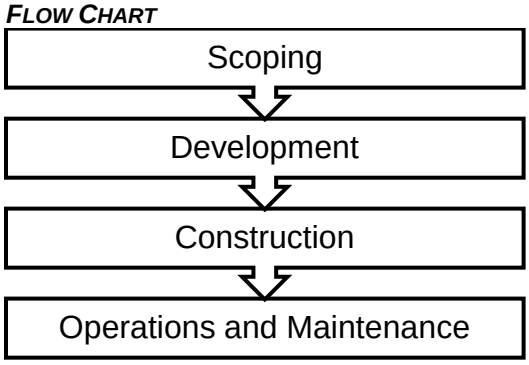
1.02 PROCESS

The TMP is introduced early in the project's life and is expanded and updated throughout the life of the project. The region / Transportation Service Center (TSC) staff determine during the early stages if a project is potentially significant or non-significant in relation to mobility impacts.

Projects are considered *significant* when they exceed the mobility threshold for the project as defined in Section 2.01 Project Significance.

The data and analysis included in the TMP varies depending on the active stage of the project. The typical project stages are summarized on **Exhibit 1-1**.

EXHIBIT 1-1: PROJECT DEVELOPMENT FLOW CHART



The process defined in the policy and this manual applies to all state trunklines regardless of the type of roadway or bridge facility, and will apply to construction, maintenance and permitted activity work zones. Each type of work zone should be analyzed in the same manner to provide consistency for travelers in Michigan. The project development process is shown in the Project Development Flow Chart and summarized herein. Additional information on the project development process is provided in Road Design Manual (Chapter 14-Procedures).

1.02.01 Scoping Transportation Management Plan (TMP)

Projects should be evaluated for safety and mobility impacts for all road users, including non-motorized users. The scoping TMP, if utilized, must ensure the constructability of the project and propose mitigation strategies as necessary. This work should be set-up with the job when it is programmed to ensure Planisware tasks are up-to-date.

If provided, the scoping TMP should be reviewed to ensure the project limits, proposed work type, and corresponding construction alternatives are accurate. The review should take place at the local office level to verify all items included are accurate and up-to-date.

1.02.02 Development Transportation Management Plan (TMP) (updated 1/20/2020)

The Development phase includes preliminary engineering activities initiated for the project and updates to the analysis performed in the scoping TMP.

The scoping TMP is reviewed to ensure that the proposed work type and corresponding construction alternatives are accurate and updated in the development TMP.

The **Development TMP** must be submitted for review, on *significant* projects only, to the WZA, *after* the Plan Review and *prior* to the Final Project Coordination (FPC) meeting. The TMP must be submitted with a ProjectWise link that directs the review team to the appropriate files.

A. Agency Coordination

Local agency officials, statewide crews and MDOT maintenance coordinators should be contacted and encouraged to attend the Plan Review, OEC Review, and preconstruction meetings to provide input regarding schedules and coordination issues. The discussion should include a review of all aspects of the TMP to determine any necessary adjustments.

TSC staff will work with local agency officials on construction schedules, coordination issues, and to obtain required permits (such as noise variances, night work, etc.), prior to construction.

1.02.03 Statewide Peer Review Team (SPRT)

To reduce delay on significant projects, all reasonable mitigation measures should be assessed to keep the delay below the project significance threshold limit as defined in Section 2.01 Project Significance. The project must be submitted to the SPRT for review when all reasonable mitigation has been implemented and the project exceeds the significance policy thresholds.

The SPRT will be established to conduct independent reviews of projects and provide recommendations for review and approval before implementation. The team should include personnel independent of the region where the project was developed, and may include:

- Region Engineer
- TSC Manager
- WZA
- Design Engineer
- Project Manager
- Construction Engineer
- Traffic and Safety Engineer
- Operations Engineer

Project reviews will be conducted as needed. Region personnel should contact the WZA to request a TMP review.

1.02.04 Statewide Peer Review Team (SPRT) Submittal Process (updated 1/20/2020)

A TMP for a significant project must be submitted for review to the WZDE, *after* the Plan Review, and *prior* to the Final Project Coordination (FPC) meeting. The TMP must be submitted with a ProjectWise link that directs the review team to all the appropriate files.

If documents within or related to the TMP are modified or updated after the TMP has been submitted and before the completed review, you must notify the SPRT of the changes. The SPRT will need a point of contact for questions during the review. This can be determined once the review date and time is scheduled.

1.02.05 Construction Transportation Management Plan (TMP)

The Construction TMP includes a review and update of the Development TMP and the Work Zone Traffic Control Plan (WZTCP).

The TMP should be reviewed prior to implementation to verify that field adjustments are not required. The TMP may also be discussed during the pre-construction meeting with the contractor and the local office overseeing the project to ensure all aspects of the plan are understood by all parties.

A. Transportation Management Plan (TMP) Implementation

The Construction Engineer is responsible for ensuring all aspects of the TMP are implemented in accordance with the WZSM Policy during the construction of the project.

Statewide, regional, and local maintenance personnel should be notified when construction, lane, roadway, or bridge closures are planned or implemented within their jurisdiction. Maintenance and permit projects may be conducted within the work zone. The Local Agency should be notified

of on-going MDOT projects within their jurisdiction.

Work zone management occurs during the construction, maintenance or permitted activity construction phases. The TMP provisions should be implemented. The work zone should be monitored, measured, and documented using field observation and other pertinent methods.

B. Work Zone Construction Peer Review (WZCPR)

A WZCPR is a project field review of safety and mobility issues conducted to offer guidance and advice for improving safety and mobility on construction projects. Peer team reviews should be conducted after the local office has implemented mitigation measures and is still experiencing either mobility thresholds or crash rates that are exceeding the anticipated design analysis. The WZCPR Team will submit their findings and recommendations to the Region Engineer for review. The review will also be used to ensure consistent statewide mobility treatments and findings may be used as reference for crash mitigations for future projects.

Members of the WZCPR Team should consist of multidisciplinary personnel, similar to that of the SPRT to ensure all aspects of the project are considered during the review. The team should be led by a member of the Work Zone Area (WZA), with at least one construction representative of the project under review.

1.02.06 Design Build Transportation Management Plan (TMP) Reviews

Design build projects reviews require an expedited turn around. Therefore, the traditional method for review must be modified. The following positions should be present for the TMP review.

- Region Engineer, or designated representative (Chair)
- TSC Manager
- Traffic Incident Management Engineer and/or Work Zone Delivery Engineer, or designated representative(s)
- MDOT Project Manager
- MDOT Deputy Project Manager
- MDOT Construction Engineer
- Region or TSC Operation Engineer
- Region or TSC Traffic and Safety Engineer/Technician

Personnel from the region in which the project is in should be used to reduce the review time required by staff due to project awareness.

The Region Engineer or a designated representative will Chair the review team and approve or reject applicable submittals. The submittal time frame and TMP review should be in accordance with project documents.

1.03 OPERATIONS AND MAINTENANCE

It is the responsibility of the operations engineer or a designated contact person to ensure that all state and contract maintenance activity is conducted in accordance with the WZSM Policy and Manual in conjunction with the Maintenance Work Zone Traffic Control Guidelines.

This includes the development of a TMP to appropriately mitigate and communicate any mobility and congestion issues within or adjacent to the work zone.

The maintenance and permitted activity work zones TMP should include the appropriate maintaining traffic details, work zone devices, and work requirements to address work zone safety and mobility impacts. Attachments to the TMP should also include analyses performed to determine time restrictions. Specific attention should be focused on the initial implementation of temporary traffic control and all temporary

traffic control changes during staged construction.

Region/TSC Traffic and Safety staff may recommend times and days of the week to perform maintenance activities to reduce potential work zone impacts. Short duration (<3 days) maintenance activities that are scheduled to occur may be modified to accommodate local needs and reduce any potential work zone impacts to safety and mobility.

- A TMP is only required for maintenance work if that work is considered long-term stationary work (>3 days), as defined by the MMUTCD.

- Mobile activities should be reviewed with the Region / TSC Operations Engineer to determine the necessary level of documentation.

- Coordination with the Region/TSC Operations Engineer and the Traffic and Safety Engineer is required and mitigation measures need to be developed as part of the TMP.

1.03.01 Restricted Routes

The MDOT Mobility Map includes mobility restrictions for MDOT facilities. Routes with mobility restrictions may require a TMP if long-term stationary (>3 days) work activities occur during restricted hours and the project impacts are significant, according to Section 2.01 Project Significance.

1.03.02 Non-Restricted Routes

Routes that do not have time restrictions for work activities require advanced notice to the Operations Engineer or the designated contact person. The required Temporary Traffic Control Plan (TTCP) should be documented and discussed with the Region/TSC.

1.03.03 Emergency Maintenance

Emergency maintenance activities performed for the safety of the transportation system should proceed simultaneously with the development of a TMP for projects that have a significant impact as defined in Section 2.01 Project Significance. Emergency maintenance activities may extend into longer durations and the TMP for significant projects will enhance safety and mobility in maintenance work zones.

This type of work zone is often of immediate nature and planning time is limited. To reduce impacts, maintenance staff should ensure the appropriate maintaining traffic details, temporary traffic control devices, work zone requirements, and public communications are implemented quickly. It is recommended that maintenance staff contact the TSC for assistance with the implementation of these items/actions.

1.04 UTILITIES AND PERMITS

If work operations are unable to be performed outside restrictions, a TMP must be developed by the permit applicant or representative and submitted in Construction Permit System (CPS) within the time frame(s) defined in the permit.

Construction permit operations must be coordinated with other projects along the corridor or within the Construction Influence Area (CIA). Adjustments must be made during construction if work zone monitoring indicates the travel time or crashes have increased. Adjustments should be documented in the TMP. Contact the local MDOT Construction Permit Office for additional information.

1.04.01 Restricted Routes

See section 1.03.01

1.04.02 Non-Restricted Routes

See Section 1.03.02

1.04.03 Emergency Operations

Access to a site during an emergency should be by the most expeditious route. Work is to be completed in a manner which provides the

traveling public with the maximum safety possible and minimizes traffic distribution.

MDOT and the law enforcement authority must be notified of emergency operations as soon as possible. The facility owner must also advise MDOT, prior to performance of work within the right-of-way. Should an emergency operation take place outside of MDOT work hours, the permittee must advise MDOT at the beginning of first day, inside of MDOT work hours. MDOT may require a permit after the emergency work is complete.

1.05 ENVIRONMENTAL CLEARANCE

Projects must be reviewed for environmental clearance and have form 1775 or 2242 completed. When determining the scope of work the details are required to be in form 1775 or 2242. For additional environmental clearance questions, or modifications to the original work plan you must contact your Environmental Clearance Coordinator or the Environmental Services Section.

1.06 TRAINING

Federal regulations require that persons involved in implementing the Work Zone Mobility and Safety Policy are trained at a level consistent with their responsibility. Training is required based on an individual's role and responsibility in implementing the policy in Michigan. This includes agencies, consultants, and contractors' staff involved in implementing the policy.

1.06.01 Annual Work Zone Training

The WZA performs yearly work zone training updates during off-peak construction times. This training covers best practices and lessons learned from the prior year's construction review. In addition, any new or upcoming policies are discussed in detail. It is recommended that MDOT and consultants attend this training. To request training dates and times, please contact the WZA.

1.06.02 TMP Training

A two-day classroom training is available and designed for all levels of experience. New methods and tools are continuously developed for work zones. The training is highly recommended for anyone developing or overseeing a TMP. To attend training contact the WZA.

1.06.03 Traffic Regulator Training

Individuals involved in traffic regulating operations for work zones must be trained in traffic regulating. Training must occur no more than 12 months before performing traffic regulating operations.

At a minimum training should consist of viewing the video How to Safely Regulate Traffic in Michigan and reading the current MDOT handbook, Traffic Regulator's Instruction Manual.

Additional information on traffic regulator procedures and conduct is available through the following resources:

- www.michigan.gov/mdotworkzones
- MMUTCD Chapter 6E
- 2012 Standard Specifications for Construction (Sections 812 and 922)

CHAPTER 2

TRANSPORTATION MANAGEMENT PLAN (TMP)

All construction projects require a TMP which is introduced early in the project and is expanded and updated throughout the life of the project. The data and analysis included in the TMP varies depending on the active project phase and project significance.

2.01 PROJECT SIGNIFICANCE

The Region and TSC staff will determine project significance based on predicted mobility impacts.

Significant Project: A project predicted to result in **greater than 10 minutes** of additional work zone delay, over normal conditions for the entire duration of the project.

Projects determined to be potentially significant require additional mobility analysis.

The level of detail included in the TMP is determined by the MDOT project manager. The impacts should be the determining factor in development of the project outreach and design.

A TMP on a significant project must include the following four (4) sections:

1. Temporary Traffic Control Plan (TTCP)
2. Traffic Operations Plan (TOP)
3. Public Information Plan (PIP)
4. Performance Assessment Plan (PAP)

A TMP on a non-significant project must include a TTCP, and the TSC must consider including the TOP, PIP, and PAP based on the project type, location and impacts.

An outline of the TMP development stages is shown in Appendix A: Project Development Process.

A Template TMP for both significant and non-significant projects are provided in Appendix C.

2.02 TEMPORARY TRAFFIC CONTROL PLAN (TTCP)

A TTCP is required for all projects and contains maintenance of traffic information. The TTCP must include, maintaining traffic plans, details, special provisions, and contract documents (i.e. notice to bidder, progress clause, coordination clause, etc.). The Special Provision that describes the construction staging for the project is commonly called *The Special Provision for Maintaining Traffic*.

Items to include in the TTCP vary by project phase, mobility impact and are summarized in Appendix A Project Development Process.

2.02.01 Maintaining Traffic Typicals

The TTCP must include or reference all applicable maintaining traffic typical plans. The typical sections vary by work zone type and location. MDOT Work Zone Typicals may be found at:

- Maintaining Traffic Typicals: Freeway
- Maintaining Traffic Typicals: Non-Freeway

- Maintenance Work Zone Traffic Control Guidelines

- Michigan Manual of Uniform Traffic Control Devices (MMUTCD Part 6)

Work zones may require further development of sample typical plans to address all project features. Plan sheets to cover these situations should be developed.

Work zones for construction, maintenance operations and other permitted activities should be implemented in the same manner for consistency.

2.02.02 Detour Routes

Detours and potential alternate routes during construction should be identified in the TTCP. Metropolitan Planning Organization (MPO) or Bureau of Transportation Planning (BTP) statewide travel demand models can be used for corridor and network level impact assessment, to identify potential alternate routes, and assess detour options.

To identify potential detours and alternate routes, Region TSC staff are responsible for project coordination discussions with other transportation agencies in the vicinity of the proposed MDOT project.

If detours and alternate routes are necessary on non-MDOT roadways, discussions with affected local road agencies must occur to verify routes are capable of accommodating additional traffic volumes. Additional detour route design information and requirements are provided in Section 6.03 Detours and Alternate Routes.

2.02.03 Multi-Modal Considerations

Potential Transit, motorized, non-motorized and shared-use facility conflicts during construction should be anticipated and addressed in the TTCP. Construction activity conflicts should be reviewed, documented and mitigated in the TTCP. The TTCP should provide reasonably safe, convenient, and traversable paths that replicate, as practical, the most desirable characteristics of the existing facilities.

Transit drop-off / pick-up locations and activities must be addressed with the transit agency which may include a temporary site relocation.

Additional information and items to consider when developing the TTCP for pedestrians and bicycles are provided in:

- Chapter 5, Pedestrian and Bicycle Work Zone Mobility

- Appendix A-Project Development Process

2.02.04 Special Provision for Maintaining Traffic

Project specific traffic restrictions and a suggested sequence of operations for traffic control should be provided in the special provision.

The *Special Provision for Maintaining Traffic* defines the TTCP for the Contractor, and may include:

- Detailed construction staging

- Maintaining traffic restrictions

- Project work
- Traffic control devices
- Construction influence area
- Temporary signing and pavement marking
- Measurement and payment of traffic items
- Estimate of temporary traffic control quantities

Work zone safety and mobility is heavily impacted during the commencement of traffic pattern modifications and the initial placement of temporary traffic control devices. These operations are ***extremely critical*** for overall work zone safety. Additional planning should be considered and documented in the TTCP.

Project staff should document which days of the week and times of the day, are the most conducive to altering or changing traffic patterns. This may reduce the impact of the initial traffic control changes and increase work zone safety.

It is the Contractor's responsibility to perform the construction activities and maintain traffic for the project according to the *Special Provision for Maintaining Traffic* and the Maintenance of Traffic (MOT) plans, unless otherwise approved by MDOT. Worker and motorist safety must be addressed when developing a plan to modify traffic conditions.

2.02.05 Preliminary MOT Cost Estimate

Cost estimates should be provided for alternative MOT options investigated as part of the TMP. These figures may justify the selection of the appropriate MOT. The scope and complexity of a project will dictate the level of detail needed in the estimating of alternatives.

Region Engineer notification is required if estimated maintaining traffic costs **exceed 25%** of the total project cost.

2.02.06 Internal Traffic Control Plan (ITCP)

The objective of the ITCP is to provide a safe traffic pattern and access plan for the contractor, equipment and materials, improving the overall safety of the work zone.

The ITCP is developed by the Contractor prior to beginning work on the project as detailed in the *Special Provision for Maintaining Traffic* and in the *Standard Specifications for Construction*, section 104.11B. The ITCP is a contract document and its development must incorporate all project specific requirements and restrictions found in the MOT SP.

The ITCP should include internal haul routes, work zone access points, and should consider the following:

- Reduce equipment back-ups.
- Limit contractor access points within the work zone. Attention should be given to ingress and egress locations.
- Establish pedestrian and worker free areas where possible.
- Establish work zone layouts appropriate for the work type being performed.

- Provide signs within the work zone to give guidance to workers, equipment, trucks, and drivers.

- Evaluate acceleration / deceleration areas.

- Design buffer spaces to protect workers from errant vehicles or equipment.

- Establish a maintenance plan for temporary traffic control devices.

A. Review

The Contractor must develop and submit for review an ITCP in accordance with the MOT to reduce conflicts within the work zone. A plan for further communication of the provisions of the ITCP and the overall construction safety plan must be discussed at the pre-construction meeting.

This includes briefing truck drivers on the following points:

- Accessing the project site

- Path to follow while traveling within the site.

- Where to stop for staging

- How a spotter will instruct them when working near other equipment

- Procedures for leaving the project area and re-entering traffic

B. Construction

The ITCP should be reviewed and updated on a regular basis at project safety meetings throughout the life of the project. The updated ITCP should be distributed to all personnel working on the project, including inspectors and all sub-contractors.

The prime contractor, safety officer or designated person for each work shift is responsible for monitoring and correcting non-compliant behavior.

2.02.07 Incentives / Disincentives (I/D)

I/D clauses may be used for a multitude of reasons not related to user delay. If the focus of use is user delay related, the I/D amount should be based on user delay costs.

The Mobility Analysis tools may be used to determine if an I/D clause is warranted. If warranted the tools can be used to estimate user costs.

The contract I/D should be included in the Progress Clause and should be noted in the TMP.

2.02.08 Temporary Traffic Control Plan Strategies (TTCP)

The following TTCP strategies may be useful for mitigating impacts on construction projects. They include strategies for use in the following categories:

- Operations

- Work restrictions

- Contracting Methods

- Coordination

- Traffic Control

  Large complex projects may incorporate a number of these strategies. Options listed below

should be considered by project offices and engineering judgement should be utilized when determining appropriate strategies.

2.02.09 Alternatives Analysis

As part of the scoping and Call for Projects process, the proposed project work types' and corresponding construction alternatives should be analyzed and evaluated to determine the recommended scope of work for the project. Each work type and construction alternative will require a review of the appropriate TTCP, taking into consideration existing operational factors within the project limits.

The Associate Region Development Engineer approves the proposed work type. The construction alternatives including the approved project concept should be analyzed to determine the impact of the project on the existing roadway and adjacent corridors. Compare the results of the analysis with the existing conditions for use in the development of the TTCP.

On larger projects having a public survey to determine which method the locals would prefer is also an effective option. Public buy-in may allow for a more aggressive schedule, larger areas closed, but less construction time. If there are two equivalent methods, the public opinion is an item that can be used to make a final selection.

The alternative analysis should consider including the items summarized in Section 2.02.02 Work Zone Mobility Analysis.

Exhibit 2-1: Temporary Traffic Control Plan Strategies: Operations

• Facility Closure: full, partial, short term, ramps, approaches, detours, alternate routes
• Reduced shoulder and lane widths to maintain number of lanes
• Reduced length of work zone lane closures or impact area, segmenting work zone
• Lane closure to provide worker safety, increased lateral buffer
• Lane shift to shoulder / median to maintain number of lanes
• Temporary median crossovers in lieu of part-width construction activities (allows full work access to one-half of roadway)
• Split / Merge
• Temporary access: road approaches, work zone access, ramps
• Temporary connections: ramps, offset intersections
• Temporary or permanent widening to maintain traffic
• Overbuilding: beyond normal project needs to maintain additional traffic
• Alternating traffic on one-lane roadway
• One-way detour
• Reversible lanes (moveable barrier, signing, marking, etc…)
• Signal timing modifications within the project work zone and/or alternate and detour routes
• Pedestrian detour or accommodations

EXHIBIT 2-1: TEMPORARY TRAFFIC CONTROL PLAN STRATEGIES: OPERATIONS CONTINUED

• Posted alternate routes
• Geometric and capacity improvements within the project limits or on alternate/detour routes (e.g. additional turn lanes, curb improvements, pavement markings, widening)
• Vehicle restrictions (trucks, oversize, local traffic, etc.)
• Emergency vehicle access
• Emergency pullouts for disabled vehicles or enforcement
• Alternative bridge designs: super girders, false work restrictions, temporary structures, bridge slide, accelerated bridge construction
• Existing rumble strip modifications as part of a traffic shift.
• Consider stage limits on arterial projects to minimize impacts to cross streets

EXHIBIT 2-2: TEMPORARY TRAFFIC CONTROL PLAN STRATEGIES: WORK RESTRICTIONS

• Night work requirements
• Weekend work requirements
• Weekday off-peak
• Hourly restrictions (e.g., no work or lane closures from 4:00 pm to 6:00 pm)
• Staged traffic control: moving work operations or unlimited work operation
• Accelerated work schedules: impact duration reduction
• Number of days to complete with full closure or significant delay (as defined in Section 2.01 Project Significance)

EXHIBIT 2-3: TEMPORARY TRAFFIC CONTROL PLAN STRATEGIES: CONTRACTING METHODS

• Incentive / Disincentive (I / D) clauses for early completion or open to traffic dates
• Lane rental
• Ramp rental
• Expedited schedules
• Innovative construction (pre-cast, rapid cure)
• Performance based traffic control: contractor incentives for efficiency and safety
• No Excuse project completion / open to traffic dates

EXHIBIT 2-4: TEMPORARY TRAFFIC CONTROL PLAN STRATEGIES: COORDINATION

• MDOT projects in area
• Local projects in area
• Local special events
• Large traffic generators
• Utility coordination
• Railroad coordination
• Permit coordination
• Incident response patrols (towing): delay reduction through quick response
• Law enforcement patrols: safety issues, speeding, driving under the influence (DUI), aggressive drivers

EXHIBIT 2-5: TEMPORARY TRAFFIC CONTROL PLAN STRATEGIES: TRAFFIC CONTROL

• Temporary signs (Warning, Regulatory, Guide, and Information Signs)
• Changeable message signs (both portable and static)
• Lighted arrow panels
• Channelizing devices (drums, 42" channelizing devices)
• Temporary pavement markings
• Traffic regulators
• Uniformed police officers for traffic control
• Temporary traffic signals
• Lighting devices for equipment or work zone
• Temporary barrier
• Mobile Attenuators
• Temporary rumble strips
• Work zone ITS traffic management: driver information, Stopped Traffic Advisory, demand management, late merge / early merge
• ITS devices and strategies
• Movable barrier systems or contra flow activities
• Temporary delineators/tubular markers
• Water-Filled Barrier

2.03 TRAFFIC OPERATIONS PLAN (TOP)

The TOP includes strategies and mitigation measures for operation and management of the work zone, adjacent network corridors and the facilities impacted by the work zone, including all transportation modes (roadway, transit, freight, rail, air, and pedestrians).

2.03.01 Work Zone Mobility Analysis (updated 1/20/2020)

The work zone mobility analysis is detailed in Chapter 3 Mobility Analysis. The following information is necessary to perform the mobility analyses which should be included in the TOP.

A. Traffic Information

Most traffic information utilized during scoping, planning, and development phases can be found on the Transportation Data Management System (TDMS). Public traffic data information may be found through MDOT and local agencies. Contact the local MPO for additional resources, if not detailed below:

- MDOT TDMS
- RITIS
- GVMC TCDS
- Tri-County RPC - MPO TCDS
- SEMCOG TCDS
- KATS TCDS

Traffic data elements that may be available on these sites include:

- Traffic Data
    - Average Daily Traffic (ADT)
    - Commercial Annual Average Daily Traffic (CAADT)
    - Design Hour Volume (DHV) Percentage
    - Directional Distribution
    - Growth Rate
    - Hourly traffic volumes
    - Hourly vehicle classification volumes
- Permanent Traffic Records (PTR)
    - Hourly
    - Daily
    - Monthly and annual reports
    - Vehicle classification (limited locations)
    - Average speeds (limited locations)
- Operational Type Traffic Studies
    - Travel time (very limited)
    - Turning movements

If not available through TDMS or other sources, the traffic data necessary to support the analysis may be requested from BTP, Asset Management Division, Data Collection Section.

Complete MDOT Form 1776, Traffic Survey Request. It is important to define the traffic data needs early in the process to provide time to collect the data.

If the necessary information is not available, the project manager may request additional data with MDOT Form 1730 Traffic Analysis Request.(TAR).

The TAR includes:

- Traffic Projections
    - Project Route
    - Detour Route
- Traffic Data
    - ADT
    - CAADT
    - Percent CCADT
    - Commercial DDHV
    - Directional ADT
    - 30th High Hour Total (DHV)
    - 30th High Hour Directional (DDHV)
    - AM Peak Hour Volume and Time
    - PM Peak Hour Volume and Time
    - Work Zone Traffic Diversion
    - Vehicle Classification
    - ESALs
    - Medium/Heavy Trucks
    - 24-Hour Traffic Distribution

B. Travel Time Analysis

The travel time analysis is dependent upon the type of roadway facility. Each roadway facility must be evaluated for the length of the project for existing conditions. Traffic volumes, speed, commercial vehicles, and roadway conditions may vary through the project corridor. It may be necessary to evaluate the roadway in sections to determine the total travel time.

The analysis must include the delay incurred at intersections (signalized and un-signalized) where applicable and must be performed for the existing conditions.

The travel time analysis must also include the peak periods of the day and the average off-peak hour for an average day ideally, during the construction season. Additional peak hour analysis may be necessary based on the site conditions and existing or proposed work zone operations. See Section 3.01 Travel Time for additional information regarding travel time analysis.

Regional Integrated Transportation Information System (RITIS) data may be used to supplement travel time runs for areas that have data available. The results should be checked against actual travel time runs.

During the scoping process, work zone travel time delay must be estimated. Travel time must be estimated for the work zone during construction and compared with existing conditions.

As the construction staging and existing operational factors are refined, the project must be confirmed for its significance according to Section 2.01 Project Significance.

C. Queue Lengths Analysis

Queue lengths provide a quantitative measure of when the demand exceeds capacity and a queue forms. Spreadsheet tools or software are helpful in performing the computation of queue delay since the accumulation and dissipation of queues may occur across multiple time periods. For additional information, see Section 3.03 Mobility Analysis Tools.

D. Operational Factors

The existing operational factors must be reviewed and documented in the TMP. The factors are necessary for determining work zone alternatives and impacts within the construction influence area.

Existing operational factors to be considered, include, but are not limited to the following:

- **Access**
  - Development Site Access
  - Parking Access
  - Emergency Services
  - Transit Routes
  - Local Considerations
  - Local Agency Projects
  - Other MDOT Projects
  - Noise / Work Restrictions
  - Schools
  - Special Events
- **Roadway Considerations**
  - Geometry / Lane Configurations
  - Height Clearance
  - Over-width Clearance
  - Railroads
  - Roadside Hazards
  - Traffic Signals
  - Utilities

E. User Delay Costs

The user delay cost represents a portion of cost that results from people, goods, and services being delayed in work zone traffic. This information may be used to evaluate MOT alternatives and monetary contractual obligations, such as Liquidated Damages, for other departmental costs.

2.04 WORK ZONE CRASH ANALYSIS

An existing base line crash analysis is performed as part of the design process. In addition, a similar work zone set-up from a previous project should be reviewed to determine if a crash pattern existed and if mitigation measures can be utilized. If a similar location cannot be found, looking at the same work type on a different roadway type may provide valuable information. If you are not aware of a project for comparison, contact the WZA.

Most work zone crashes are congestion related. Typical work zone crashes due to this condition are rear end crashes and are a result of traffic queues. Other contributions to work zone crashes are

due to lane width restrictions and lane shifts in close proximity to fixed objects. The TTCP should include the proper traffic control devices to warn motorists of changes in road conditions.

2.05 DESIGN CRASH ANALYSIS

A detailed crash analysis should be completed for the normal roadway operation and for the various proposed construction staging options. Detour and alternate routes should be included in the analysis.

To perform an analysis, the Region/TSC Traffic & Safety Operations Engineer should perform the following steps:

- Identify a project similar location, size, traffic type and traffic control design that is already constructed.

- Determine the mile points of the project. Include the advance signing sequence and additional mileage to capture potential back of queue crashes.

- Retrieve crash data related to similar projects.

- Determine an average crash rate using the previous three years during the anticipated construction times.

- Determine what crashes occurred and where they occurred due to the work zone by reviewing individual crash reports.

    - *Are there correctible patterns or locations?*

- Determine what crashes occurred in the work zone not related to work zone activities.

    - *Are there correctible patterns or locations?*

- If no pattern exists, typical crash patterns can be expected to develop at interchanges, ingress/egress points, contractor access points and lane closures or shift locations.

    - *Are established best practices in use by MDOT that could be employed to reduce expected crash patterns?*

Following the review, determine if best practices or policies developed for a similar project exists and if relevant, apply it to the proposed project.

Designers are encouraged to investigate mitigation techniques employed by other TSCs for similar projects. The websites provided in Appendix G (Resources) and the list of common strategies and tools to reduce crashes in work zones in Section 4.04 Work Zone Crash Reduction Strategies may also offer potential mitigation techniques.

It is each region's responsibility to retain the information, analysis, and mitigation measures in project files.

Crash data is available using Roadsoft. The data may be obtained by contacting the Bureau of Development, Traffic and Safety Section. A delay may exist in the posting of the crash data in Roadsoft.

The safety goal for a work zone is to minimize the crash rate as much as possible. It may be possible to reduce the overall crash rates on roads under construction by implementing crash reducing maintaining traffic strategies depicted in Section 2.10.03 Work Zone Crashes.

2.05.01 Agency Coordination

MDOT should identify and contact local agencies during the design process to discuss MOT plans, special provisions and to further define the TOP.

The approved Five-Year Program includes initial project schedules from which the Region, BTP, and STP staff may begin mobility discussions with other road agencies and affected local government units (cities, villages, townships, Sovereign Nations, etc.) through the MPOs, Rural Task Force (RTF) and Regional Planning Agencies (RPA). Region or TSC staff are responsible for leading project coordination discussions with other transportation agencies in the vicinity of proposed MDOT projects.

Discussions should include potential detours and alternate routes during construction to avoid conflicting local and trunkline work on parallel and adjacent routes. If potential conflicts are noted, region or TSC staff may need to contact the BTP for assistance in determining the project influence area and scope of roadways impacted, for projects determined significant as defined in Section 2.01 Project Significance.

The Region Traffic Safety & Operations Engineer should ensure the TMP considers the impacts of other projects in development along the corridor or within the CIA of the project.

Contact the BTP to coordinate network and corridor modeling for high impact projects (determined by PM). Travel demand models provided by the MPO, BTP, or consultant may be used to evaluate the following:

- Corridor and network level impact assessment
- Identify potential alternate routes
- Review detour route alternatives

The following local, regional, state, national and international agencies that may be included in discussions regarding the TOP:

- Local Government
- Local Police & Public Safety Department
- County Sheriff Department
- Michigan State Police
- Local Fire Department
- Medical Emergency Services
- Dispatch Centers
- Local Public Transit
- Regional Public Transit
- Railroads
- U.S. Customs and Border Protection
- Sovereign Nations

2.06 TRAFFIC OPERATIONS PLAN STRATEGIES

To reduce delay on significant projects, reasonable mitigation measures should be assessed to keep the delay below the threshold limits. TOP strategies may be useful when considering mitigating impacts on non-significant projects. They include strategies for use in the following categories:

- Demand Management
- Work Zone Safety
- Traffic Incident Management (TIM)

See Exhibits below for additional details.

EXHIBIT 2-6: TRAFFIC OPERATIONS PLAN STRATEGIES: DEMAND MANAGEMENT

• Transit service improvements
• Transit incentives
• Driver incentives: additional transit use and alternate route use
• Shuttle services
• Ridesharing / carpool programs and/or incentives
• Park and ride promotion strategies
• High occupancy vehicle (HOV) lanes
• Ramp metering
• Variable work hours
• Telecommuting

EXHIBIT 2-7: TRAFFIC OPERATIONS PLAN STRATEGIES: WORK ZONE SAFETY

• ITS (including real time work zone systems)
• Attenuators (impact and truck-mounted)
• Bus turnouts
• Coordination with adjacent construction site(s)
• Freeway Courtesy Patrol
• Dynamic lane closure system
• Reflective panel for sign supports
• Moveable traffic barrier systems
• Off-site street and intersection improvements
• Parking restrictions
• Ramp closures
• Reversible lanes
• Road Safety Audits
• Temporary Rumble strips
• Safety award/Incentives
• Safety supervisors/inspectors
• Safety training
• Separate truck lane(s)
• Signal timing / coordination improvements

EXHIBIT 2-7 CONT.: TRAFFIC OPERATIONS PLAN STRATEGIES: WORK ZONE SAFETY
• Speed limit reductions
• Temporary traffic signals
• TMP monitor / inspection team
• Delineators / vertical panels / channelizing devices
• Turn restrictions
• Vehicle height / width / weight restrictions
• Work Zone Reviews
• Emergency Maintenance Repairs

EXHIBIT 2-8: TRAFFIC OPERATIONS PLAN STRATEGIES: TRAFFIC INCIDENT MANAGEMENT

• ITS for traffic monitoring/management
• TOC – coordination
• Freeway Courtesy Patrol
• Emergency responders coordination (first responders)
• Surveillance (closed circuit cameras, loop detectors)
• Enhanced mile-post markers
• Traffic screens
• Emergency turnarounds / access gates
• Emergency pull-offs for disabled vehicles
• Tow service patrol
• Media coordination
• Designated local detour routes / alternate route plans
• Contract support for TIM
• Incident / emergency management coordinator
• Incident / emergency response plan
• Dedicated funding for police enforcement
• Contingency plans (stand-by equipment and personnel)
• Traffic Responsive Signal Control Plans
• Dynamic Message Signs
• Call boxes

2.07 PUBLIC INFORMATION PLAN (PIP)

The PIP includes public/stakeholder information and communication strategies that will begin during the planning and design phases as well as during construction or operations activities. The PIP includes the most efficient method of communicating this information. The PIP is intended to create an organized and systematic process to communicate work zone information to the traveling public and respective stakeholders.

Information to the road user on routes, delay, and road information are typical applications. Additional information should include updates on active work and/or worker proximity.

Work zone impacts to pedestrians and bicyclist facilities should be incorporated in the project PIP. A pedestrian or bicyclist specific plan may be needed. Additional information is provided in Chapter 5: Non-Motorized Work Zone Safety and Mobility. Public meetings held for the project are often ideal places to incorporate a pedestrian/bicycle access component to address the concerns of the larger community.

A PIP is important for long-term, significant projects as defined in Section 2.01 Project Significance. The PIP should target the general public along with representatives from schools, community centers, parks, transit, and businesses in the area to alert them of upcoming changes and to advise them of the efforts taken to accommodate pedestrian needs.

2.07.01 Communication Plan

The PIP must be finalized based on the agreed project scope in coordination with the region communication representative, ensuring that project, corridor and network ramifications are considered. The region communication representative should be an active member in the development and implementation of the PIP.

A. Public/Stakeholder Information

It is necessary to communicate project information with both the public and stakeholders to maintain a safe work zone and efficient travel. The communicated information should include but is not limited to:

- Construction timeline
- Active work area dates and times
- Staged traffic changes with dates, times, and project specifics
- Brief work description
- Emergency events notification
- Alternate and detour routes

2.07.02 Communication Methods & Strategies

Communication of project information to the affected groups must be discussed in the PIP. There are several different communication methods and will vary by project type and location. It is recommended that the project specifics are communicated prior to construction and to establish relationships that will assist during construction.

EXHIBIT 2-9: PUBLIC INFORMATION PLAN STRATEGIES: PUBLIC AWARENESS

• Brochures and mailers
• Paid advertisements
• Public information center
• Telephone hotline
• Work zone education and safety campaign
• Media press release (newspapers, TV, radio, etc.)
• Social Media (Facebook, Twitter, YouTube, etc.)
• List on MDOT Road Construction map
• Public information meetings
• Lane closure website (MI Drive)
• Advanced global area signing
• Establish Email Listserv for project (include law enforcement, emergency services, local agencies and other contractors within the influence area)
• Stakeholder updates/meetings
• Visual information (videos, presentations) for meetings and web-based viewing
• Project specific website

EXHIBIT 2-10: PUBLIC INFORMATION PLAN STRATEGIES: MOTORIST

• Public Radio
• Portable changeable message signs & Dynamic Message Signs
• Global Informational Signage
• Freight travel information (Great Lakes Regional Transportation Operations Coalition (GLRTOC), MDOT Transport Permit Unit)

2.08 PERFORMANCE ASSESSMENT PLAN (PAP)

Once the project is under construction, the PAP includes documentation of traffic delays, travel times, queues, volumes, and associated information. The information will assist in the verification of data and if additional measures must be taken to amend the TMP. Traffic incidents (crashes, load spills, natural disasters, etc.) should be documented and analyzed to determine if work zone hazards have developed that require action.

The TSC Traffic & Safety Operations Engineer should be made aware of all traffic incidents in the work zone

The WZA must be notified when a Type K (fatal) crash occurs in the work zone or in the queue, related to the work zone.

Work zone safety and mobility should be monitored, measured, and documented during the construction phase of each significant project to verify the mitigation measures and strategies are performing as expected, as stated in the TMP. The TMP will be used as the basis for the project specific PAP.

2.09 FHWA FINAL RULE

Agencies are required to use work zone data at the project and process levels to manage and improve work zone safety and mobility per the provision in Section 630.1008(c) of the FHWA Work Zone Safety and Mobility Rule.

- The project-level requires agencies to use field observations, available work zone crash data, and operational information to manage the work zone impacts of individual projects while projects are under construction.
- The process-level requires agencies to analyze work zone crash and operational data from multiple projects to improve agency processes and procedures, and in turn continually pursue the improvement of overall work zone safety and mobility.

- Recommends that agencies maintain elements of the data and information resources that are necessary to support the use of work zone data for the above activities.

Work zone data is necessary to make an informed assessment of the effectiveness of efforts to manage work zones safety and mobility impacts. Work zone field data, which includes but is not limited to volume data, diversion rates, crash rates, site observations, shy distances, etc. It also enables agencies to assess how well planning and design estimates of anticipated impacts match what happens in the field. Work zone data should support performance assessments at both the project and program-levels. Available data and information provide the basis for assessing performance and taking appropriate actions to improve performance on individual projects as well as overall processes and procedures.

Each region is responsible for retaining information, analysis, and mitigation measures used in the project files and ProjectWise.

2.10 WORK ZONE MONITORING

Traffic conditions in work zones should be monitored as determined by each region to verify assumptions and projections made during project development. Documentation of the findings and impacts of various techniques used to mitigate impacts will assist in the selection of mobility mitigation measures for future projects.

If monitoring of the work zone indicates that the actual delay times or crash rates have exceeded the anticipated thresholds, adjustments to the TOP need to be considered. When traffic operations, either directly within the project or along adjacent routes within the CIA, are not responding to the measures being implemented, additional changes need to be considered. Changes made to the TTCP or the TOP during any stage of the project may result in reevaluation. The cost and effectiveness of proposed TMP changes should be evaluated based on the mobility policy threshold criteria and all cost modifications should be approved by the Construction Engineer before implementation.

The following items may be used to document project incidents and activities:

- IDR's
- Evaluation reports
- Crash reports
- Traffic measuring devices (loops, tubes, radar, RITIS, etc.)
- Video cameras
- Additional devices or methods

2.10.01 Work Zone Field Reviews

Effective traffic control requires work zone reviews, during both daytime and nighttime conditions. The frequency of reviews for each project should be determined by the local office. The WZA should provide at least one review per TSC per construction season, for consistency and alignment. The Work Zone Audit Report (Form 0397) should be used by personnel for work zone reviews.

Recommended adjustments to the TTCP during construction should be referred to the Construction Engineer for consideration. Region/TSC Traffic & Safety personnel should also employ the form for periodic review of the temporary traffic control throughout the duration of the project.

Project staff should be actively engaged with local and state law enforcement agencies, and emergency service providers to assure open communications concerning mobility and TIM.

Crash reports should be obtained as soon as they become available. Work zone crashes should be closely monitored and documented. A crash analysis should be performed to determine if corrective action is needed.

2.10.02 Work Zone Delay

Field measurements of actual travel times and delays should be continuously documented throughout the life of the project to assess mobility in the work zone.

If the field measurements show the anticipated design thresholds are exceeded, the Construction Engineer should consider further mitigation. If delays continue to exceed anticipated threshold levels, a Work Zone Construction Peer Review should also be considered.

Each region is responsible for updating and maintaining the information needed for their projects. The information may be utilized for evaluating project and program level effectiveness.

A. Travel Time Delay

The following report may be used for recording work zone travel time delay

before, during and after each stage of construction. Work Zone Travel Time Delay Form. The worksheet includes evaluation of the following work zone delay criterion:

- Throughput
- Delays
- Unit travel times (i.e., minutes per mile traveled, also expressed as an average travel speed over the length of the roadway segment)
- Travel time reliability
- Traffic queues
- Additional travel time delay calculations may be performed using RITIS, Bluetooth, or other tools included in Section 3.03 Mobility Analysis Tools.

2.10.03 Work Zone Crashes

Work zone crashes should be documented and an analysis should be conducted. The data must include:

- Traffic crashes
- Crashes involving workers
- Non-motorized traffic

Lead workers, supervisors and/or contractors should communicate with the emergency personnel who respond to crashes within a work zone. Staff should consult with the Region/TSC Traffic & Safety Engineer and the WZCPR Team concerning potential adjustments to the work zone. This information will be used to improve safety on future projects.

Adjustments should be documented for future reference to mitigate work zone delays and crashes. Personnel may request and meet with the Region/TSC Traffic & Safety Operations Engineer to discuss the specific crash history for any route, segment or facility during work zone planning.

2.10.04 Work Zone Crashes during Construction

Monitoring work zone crashes during the project and reviewing potential corrective actions may help reduce or eliminate crashes. The Construction Engineer should assign a staff member to monitor work zone crashes during the project. Crash reviews may also indicate no corrective action is needed. The monitor should establish open communication with law enforcement agencies that patrol the project and request notification of crashes and collect crash report information as soon as it is available.

Project staff should provide project information to towing companies or provide a towing service on the project to keep roadways clear. Towing services should be included in the TTCP design when shoulder width is limited or when no emergency pull-offs exist.

The project staff should work with emergency service, and first responders to develop incident response plans. Incident responders are responsible for the protection of the incident area. Incident response plans should contain provisions to initiate site protection with the goal of reopening the lanes or roadway as safely and quickly as possible.

On-site inspections and constructive input by staff, not specifically assigned to the project, should be encouraged. Those less familiar may observe additional items that benefit the project.

Modifications or changes to the work zone based on field feedback should be shared with the design staff. This allows

the items to be addressed in future work zone designs.

When issues occur that cannot be corrected at the project level, you can request assistance from the WZDE or set-up a Work Zone Construction Peer Review as detailed in section 1.02.05.B.

2.10.05 Program Performance Measures

Performance measures are evaluated to ensure successful implementation and continual improvement of MDOT's Work Zone Safety and Mobility Policy. The construction phase and the post construction season evaluation are the focus of these measures.

The WZA will share (when available) data collection techniques and best practices utilized throughout MDOT regions to standardize the mobility analyses and post-season assessments process, to ensure efficiency and effectiveness.

2.10.06 Process Review

On a biennial basis, a process review must also be conducted that includes an overall assessment of the WZSM Policy. This review will be administered by the WZA The Unit will review and document each region's implementation activities. They will also assess the uniformity of implementation across the regions.

The WZA Unit will provide a biennial report to FHWA, Michigan Division on the compliance status of the WZSM policy implementation with respect to the Federal WZSM Rule. Suggested improvements to the policy and revisions to the manual may also be included in the report.

2.10.07 Statewide Project Review

Statewide level measures may include evaluation of how many or what percentage of significant projects meet policy goals. The following items should be considered for program reviews:

- **Travel Time Delay**
  How many projects were able to meet the 10 minute work zone delay threshold?

- **TMP**
  How many projects were in substantial compliance with TMP requirements?

- **Work Zone Compliance**
  How many projects received satisfactory work zone safety review ratings?

- **Work Zone Crashes**
  How many projects experienced a change in crash patterns (and/or rates) both positive and negative, during the project duration?

Program review results may be used to determine focus areas for the biennial process review and will help evaluate project significance thresholds. Calibrating the customer's perception of what is tolerable compared to the established threshold may vary by region or area.

2.10.08 Travel Time Delay

Travel time delay is the most understandable and quantifiable parameter to the motorist and is considered the primary program-level measure for achieving mobility goals.

Tolerable delays within a work zone have been established according to the mobility thresholds as defined in Section 2.01 Project Significance. The success of the WZSM Policy depends directly on how often a motorist actually experiences

work zone impacts that are perceived as intolerable.

Actual travel time delays should be periodically measured by field personnel during typical peak traffic periods. A sample field data collection sheet is provided in Appendix D.

For high-volume sections, automated devices may also be utilized for data collection, to determine travel times. For more information, refer to Section 3.03 Mobility Analysis Tools.

Travel time measurements serve two primary purposes:

- Monitor and ensure vehicle delays remain at or below predicted delay levels.
- When a project delay exceeds the anticipated work zone delay, the Construction Engineer should be notified and mitigation measures assessed and implemented.

2.10.09 Work Zone Compliance

A work zone survey may be distributed on an annual basis by the WZA to each region to determine focus areas for the following construction season.

Each region should review ongoing projects and make necessary adjustments during the construction season. For each project review, a standardized report (Form 0397) may be completed that will yield the following determination.

- Was the work zone in substantial compliance with the provisions of the contract documents or agreements during the review?

2.10.10 State Wide Work Zone Crash Evaluation

The WZA will perform a yearly high level work zone crash analysis. Each Region may compile a summary report of work zone crash data for submittal to the WZA for analysis. The summary may display the number (or percentage) of projects that showed an increase or decrease in crashes during construction from pre-construction conditions.

Crash data from the period beginning on the start date of the construction project and ending on the completion date of the project, may be compared to crash data from the same period for the previous three years. This detailed review is a best practice and should be considered when the overall volume of crashes increases for the region compared to the previous year.

Assistance may be available from the WZA if all the required project information (dates and locations) is provided. Noticeable and noteworthy trends detailing when and where crashes have increased will be presented during work zone safety trainings. For more detail, refer to Section 2.04 Crash Analysis for more detail).

2.10.11 Customer Feedback and Perception

Customer feedback is essential for assessing whether the current project significance thresholds match what motorist consider tolerable as defined in Section 2.01 Project Significance. The effectiveness of the policy will also be assessed and may be calibrated to what motorists consider tolerable

2.10.12 Project Review

The provision pertaining to use of work zone data is provided in Section 630.1008(c) of the WZSM Rule. It requires agencies to continually pursue improvement of work zone safety and mobility by analyzing work zone crash and operational data from multiple projects to improve agency processes and procedures.

Work zone data may be used to conduct post-construction evaluations, support process reviews, develop lessons learned, and ultimately improve agency policies and procedures. This data is typically available during project implementation and must be documented for post-construction analyses. It should include project contacts, supporting data, analysis techniques and results, work zone monitoring data, work zone reviews, and other related information. Project-level performance measures are summarized as follows:

- Roadway type
- Total delay field measurements
- Work zone audit reports
- Traffic crashes
- Public Feedback

CHAPTER 3

MOBILITY ANALYSIS

The mobility analysis process should be applied to all projects and related activities to determine work zone mobility impacts needing further review, mitigation, or approval. The mobility analysis is vital and should be initiated during the planning phase. Significance threshold is based on work zone travel time delay as defined in Section 2.01 Project Significance.

The most common tool used at MDOT for mobility analysis is a Construction Congestion Cost (CO^3) tool. CO^3 is used for uninterrupted flow, including traffic regulator operations. Other methods can also be used to supplement the mobility analysis.

3.01 TRAVEL TIME

The travel time delay should be estimated for the work zone to determine project significance as defined in Section 2.01 Project Significance. Consideration should be given to:

- Speed delay: Results from the reduced travel speed in the work zone, in comparison to the existing condition. This is affected by the temporary speed limit and by the capacity of the work zone.
- Queue delay: Additional time vehicles spend waiting in a queue. This is a result of the accumulation of vehicles upstream of a capacity reduction (i.e. a lane closure) when the demand exceeds the capacity.
- Control delay: Interruptions in traffic flow caused by temporary traffic control devices. Interruptions occur on all roadway types and include planned events (i.e. traffic regulators, temporary signals, temporary traffic stoppages).

Past experience should also be a factor when estimating travel times. Diversion rate of past projects in similar locations should be utilized to refine your estimation of work zone delay.

3.01.01 Un-interrupted Flow Facilities

Computing travel time for uninterrupted flow facilities (i.e. freeways or non-freeway without stop controlled or signal controlled intersections) consists of determining the speed delay and the queue delay.

A. Capacity Determination – Freeway

Table 3-1 Base Mainline Capacity and Table 3-2 Capacity Adjustment Factors should be used to estimate the capacity for each open lane. Apply factors known to adjust the base work zone capacity.

To begin the development of traffic control options, determine the number of lanes needed to handle the expected demand. An early check of available roadway capacity is critical as the vast majority of additional delay due to a work zone occurs when demand exceeds capacity for any appreciable length of time. The Highway Capacity Manual (HCM) Equation 10-9 can be used to determine the resulting adjusted capacity of the roadway lane:

$$C_a = \{[(C_b + I_g + I_{wt} + I_{wa}) \times f_{hv} \times f_{lw} \times f_{sc}] \times N\} - R$$

Where:

C_a = adjusted mainline capacity - vehicles per hour (vph)

C_b= base mainline capacity - vehicles per hour per lane (vphpl)

I_g = adjustment factor for geometrics (ranges from –150 to +250 vphpl, could be zero). Select multiple factors that apply depending on the conditions; apply the cumulative adjustment factor.

I_{wt} = adjustment factor for intensity of the work activity (ranges from –200 to +200 vphpl, could be zero). Select one factor.

I_{wa} = adjustment factor for location of the work activity (ranges from –150 to +200 vphpl). Select one factor.

f_{hv} = adjustment for heavy vehicles as defined in HCM Equation 10-8. Values have been provided for typical truck volume ranges

f_{lw} = adjustment for lane/shoulder widths

f_{sc} = adjustment for lane/shoulder side clearance

N = number of lanes open through the work zone

R = manual adjustment for entrance ramps (vph).

The adjustment factor for work zone geometrics may be considered cumulatively. For example, work zone geometry when traffic uses a crossover and requires a traffic shift >3 feet would apply the cumulative effect of each condition as a part of the adjustment factor.

When determining the factors engineering judgement should be used to determine if the factors should be applied cumulatively. The base mainline capacity ***(C_b)*** and work zone capacity adjustment factors are provided in the tables below.

Table 3-1: Base Mainline Capacity

Number of Lanes		Starting Capacity per Lane
Normal	Open	C_b
3	1	1400
2	1	1550
5	2	1600
4	2	1700
3	2	1700
4	3	1750

Table 3-2: Capacity Adjustment Factors*

Work Zone Conditions**	**Capacity Adjustment Factors***		
Geometry: traffic uses crossover	I_g	Subtract	150 vphpl
Geometry: traffic driving on shoulder		Subtract	150 vphpl
Geometry: traffic shift (>3 feet)		Subtract	100 vphpl
Geometry: work activity adjacent, protected with temporary barrier		Add	250 vphpl
Geometry: work activity adjacent (< 15 feet), protected by channelizing devices		Subtract	100 vphpl
Work Type: pavement repairs (concrete or HMA)	I_{wt}	Subtract	200 vphpl
Work Type: rubblizing, reconstruction		Subtract	150 vphpl
Work Type: overhead activity (i.e. bridge work – painting, patching)		Subtract	150 vphpl
Work Type: cold milling, paving (concrete or HMA)		Subtract	100 vphpl
Work Type: guardrail or barrier		Add	50 vphpl
Work Type: signing installation		Add	50 vphpl
Work Type: occurs > 20 feet away		Add	100 vphpl
Work Activity: adjacent lane distance < 12 feet	I_{wa}	Subtract	100 vphpl
Work Activity: adjacent lane distance > 12 feet , < 20 feet		Subtract	50 vphpl
Work Activity: adjacent lane distance > 20 feet away		Add	150 vphpl
Work Activity: separated by median		Add	50 vphpl
12' lane width	f_{LW}	Multiply	1.00
11' lane width		Multiply	0.95
10' lane width		Multiply	0.90
Restricted one side	f_{SC}	Multiply	0.95
Restricted both sides		Multiply	0.90
Trucks 0% to 5%	f_{HV}	Multiply	1.00
Trucks >5% to ≤10%		Multiply	0.98
Trucks >10% to ≤15%		Multiply	0.95
Trucks >15% to ≤20%		Multiply	0.93
Trucks >20%		Multiply	0.90
Entrance ramp within 1,500 feet downstream from the end of the lane closure taper	R	Subtract	Hourly ramp volume (max 600 vph)

* When calculating C_a the final result should range from 1,100 VPHPL to 2,000 VPHPL. If the result comes back outside of this range please contact MDOT's Work Zone Delivery Engineer for approval.

** If multiple work zone conditions occur, use engineering judgement to determine which factors to use. The final number must fall within the range of the largest values for that adjustment factor.

*** Please send verified delay measurements to the TI&WZSM Unit. This will allow for adjustments to the numbers based on real world experiences.

Example 3.1: Freeway
A construction project is planned for a two-lane freeway portion of US-127. The project will last for several months and involves complete reconstruction of the roadway and several bridges on each bound. One lane of traffic is proposed to be maintained in each direction by using temporary crossovers. Maintained traffic must drive on the shoulder. Lane widths will be reduced to 11 feet, with temporary concrete barrier separating opposing traffic. The traffic characteristics consist of 7% trucks.

Solution 3.1: Freeway
The lane capacity is computed by starting with the base capacity (C_b) for a 2 lane freeway to a 1 lane freeway 1550 vphpl. The adjustment factor applied for geometry includes use of a crossover, with a >3 foot shift, and traffic driving on the shoulder. Since we are only allowed to use one factor I_g=-100 (could range from 100 to 150). Although the work type is reconstruction, it is not in close proximity to the maintained traffic since it occurs on the closed bound of the freeway (I_{wt}=100). The adjustment factors applied for work activity (I_{wa}=50), lane width (f_{lw}=0.95), side clearance (f_{sc}=0.95), and percent trucks (f_{hv}=0.98). The adjusted capacity is:

$$\boldsymbol{C_a} = [(1550 - 100 + 100 + 50) \times 0.95 \times 0.95 \times 0.98] = 1415\ \boldsymbol{vph}$$

Example 3.2: Freeway
A construction project is planned for an urban three lane freeway portion of I-696. The project will last a few months and involves replacement of median barrier and lighting fixtures. The median lane will be closed in each direction during some parts of the day using channelizing devices. The work activity is less than 12 feet from traffic. The traffic characteristics consist of 15% trucks.

Solution 3.2: Freeway
The lane capacity is computed by starting with the base capacity (C_b) for a 3 lane freeway to a 2 lane freeway 1700 vphpl. Adjustments are applied for close proximity intense work activity (I_g=-100), (I_{wt}=50), (I_{wa}=-150), side clearance (f_{sc}=0.95), percentage trucks (f_{hv}=0.95). The adjusted capacity for two open lanes is:

$$\boldsymbol{C_a} = \{[(1700 - 100 + 50 - 100) \times 0.95 \times 0.95] \times 2\}$$
$$= \boldsymbol{or\ 2798\ vph}\ or\ \boldsymbol{1399\ vplph}$$

B. Traffic Demand Determination

An estimation of the hourly traffic demand is necessary to proceed with travel time delay and queue estimations. Existing traffic volume data is regularly collected on most state trunklines. Information regarding traffic data is provided in Section 2.03.01.A Traffic Information.

The level of detail of traffic volume data depends on the level of analysis. Hourly traffic volume data is necessary to accurately evaluate mobility impacts on facilities that may have fluctuations in traffic demand throughout the day. This is of particular importance if the temporary traffic control plan considers implementing traffic restrictions or lane closures only during certain portions of the day.

Weekend and weekday volumes are necessary when determining week day restrictions. Reviewing traffic volumes from the same time frame is important to make sure the traffic patterns are similar. This is amplified when dealing with an area that has a yearly traffic generator such as a school or seasonal traffic.

C. Speed Delay

The speed delay component of travel time delay is affected by the temporary speed limit and by the capacity conditions of the work zone. As a base line, the initial travel time (before construction work) should be computed or measured. Most roadways that operate at less than capacity, the initial travel time may be estimated by dividing the segment length by the existing posted speed limit. It should be recognized, however, in areas where recurring congestion is present, the existing travel time should be inclusive of recurring congestion due to near or at capacity operations.

Measured operating speed may be available on RITIS. Existing travel time runs should be completed to verify the existing conditions.

The proposed posted temporary speed limit should be considered the maximum operating speed during construction activities. It is important to consider the presence of special reduced speed limits in Michigan, such as the “45 MPH Where Workers Present” condition. The actual operating speed within a work zone may still be less than the posted work zone speed depending on the capacity conditions and worker location.

The relative nearness of the traffic demand to capacity is related using the V /C ratio. The V/C ratio may be used as a performance measure for the work zone operations.

The speed delay attributable to the work zone can be computed as the difference in the travel time during construction and before construction. The following formula may be used to compute speed delay:

$$t = D \times \left(\frac{1}{U_{wz}} - \frac{1}{U_i}\right) \times 60$$

Where:

t = speed delay (min)

D = work zone length, from reduce speed signing to return to existing roadway speed (miles)

$\mathbf{U_{wz}}$ = operating work zone speed (mph);

$\mathbf{U_i}$ = existing posted or operating speed before construction (mph)

D. Queue Delay

A queue is an accumulation of vehicles for each time period in which the arrivals, or demand, exceeds the departures, or capacity. The queue delay component of travel delay is estimated only when the demand exceeds capacity and a queue

forms. When the demand traveling through the work zone is less than or equal to capacity, no queue is formed and no queue delay is encountered.

Spreadsheet tools or software are helpful in performing the computation of queue delay, since the accumulation and dissipation of queues may occur across multiple time periods. The delay encountered at a queue is estimated using the volume of vehicles accumulated in the queue and the capacity at which the queue is serviced. The following formula can be used to compute the delay time for a vehicle at the back of the queue:

$$t = \left(\frac{Q}{C_a}\right) \times 60$$

Where:

t = queue delay (min)

Q = # of vehicles in queue (# of veh)

C_a = adjusted mainline capacity (vph)

Example 3.3:
Urban Freeway, Queue Delay

Building from Example 3.2, the demand on this urban freeway is 3000 vph. The work zone is 5 miles long and the existing posted speed is 70 mph. During Construction the work zone will be signed for:

45 MPH
Where Workers Present.

Solution 3.3:
Urban Freeway, Queue Delay

The adjusted mainline capacity estimated earlier is 2798 vph. The accumulated queue for the time period (hour) is the demand that exceeds the capacity.

$$Q = 3000 - 2798 = 202\ veh$$

The queue delay is:

$$t = \frac{202}{2798} \times 60 = 4.33\ \boldsymbol{min}$$

T*able 3-3: Per Lane Capacity for Signalized Flow*

Lane Characteristics			No Turns		50% Turns*		100% Turns* or Right-turn lane		U-turn crossover
Lane Width (feet)			12	10	12	10	12	10	N/A
Green Time	40%	Unrestricted	620	550	560	500	520	450	530
		Restricted	580	510	520	460	480	420	490
	50%	Unrestricted	850	750	770	680	710	620	670
		Restricted	800	700	730	640	670	590	630
	60%	Unrestricted	1040	910	940	830	870	760	810
		Restricted	970	850	880	780	810	710	760

Assumptions for Table 3-4: 5% trucks, level terrain, urban area

* Assumes no left turns through opposing traffic from lane analyzed. Left turns with opposing traffic merit special consideration. If no opposing traffic exists, left turns are treated as right turns. For example: no opposing traffic, 30% rights & 20% lefts , use table values for 50% turns.

3.01.02 Traffic Regulator Operation
(updated 1/20/2020)

Traffic regulator operations, on the mainline traffic with alternating flow, should be evaluated based on travel time delay. The travel time delay calculation is determined using the Construction, Congestion, Cost Software (CO3) Flag Spreadsheet. The capacity of a traffic regulator operation is directly related to the posted work zone speed, volume of traffic, and the length of the traffic regulator zone.

The chart and graphs provided in Appendix B: Mobility Analysis Tools present capacity during traffic regulating on two-lane roadways. Once this determination is made, it can be used in the CO3 analysis to evaluate the travel time delay associated with work zone lengths. The value, as determined by the chart and the CO3 analysis, should be specified in the TMP. The length of the work zone and other design restrictions must also be placed in the Special Provision for Maintaining Traffic.

Example 3.4:
Traffic Regulator

A seven mile milling and resurfacing construction project is scheduled on a two lane, two-way portion of M-44. Construction operations allow for traffic regulator control to maintain one lane, alternating during working hours, and two lanes open during non-working hours. The existing posted speed is 55 mph and the work zone will be signed for 45 mph.

Solution 3.4:
Traffic Regulator

Traffic count information for this location can be found at MDOT TDMS. The TDMS data indicates that the AADT is 5,950 vehicles for this segment. This traffic volume is cumulative of both directions of travel. If a breakdown of hourly traffic is available it must be used or the AADT number needs to be converted using the design hour volume (DHV) in vph.

Multiply the AADT by the DHV % to obtain the DHV. TDMS indicates that the DHV% for this segment is 12%:

$$(\mathbf{5{,}950}\ \boldsymbol{veh}) \times (\mathbf{12\%}\ \boldsymbol{DHV}) = \mathbf{714}\ \boldsymbol{vph}$$

Use the table for Appendix H. Capacity in Traffic Regulator Zones to determine the maximum allowable length of the work zone given the 45 mph speed limit. The design hour has 714 vph. Utilizing the table for Appendix H. Capacity in Traffic Regulator Zones traffic regulation operation will result in delays of 10 minutes or less (714 is less than 725 which is capacity at 2.0 miles). Confirm hourly volume calculation with hourly traffic volumes if available.

The work zone length should be further evaluated using the CO3 Flagging to confirm travel time delays do not exceed 10 minutes. The allowable length of the lane closure must be specified in the Traffic Restrictions in the Special Provision for Maintaining Traffic.

3.01.03 Temporary Traffic Signals

Temporary traffic signals are often included in construction projects. They are categorized into two types, portable and fixed (pole mounted).

Portable signals may be necessary on projects when only one lane of traffic can be maintained at a time and traffic regulating operations are not recommended. On projects that extend over 30 days, the option of connecting to a power source is not required but should be considered. When a portable signal remains in place and all lanes are open, the signal should be removed or placed in yellow flash mode.

If possible, driveways or side streets within the temporary signal heads should be avoided. If unavoidable, contact the WZDE for potential solutions.

The Traffic Signals Unit should be contacted on projects that require a temporary pole mounted traffic signal. The Traffic Signals Unit does not typically provide timing permits for temporary portable traffic signals, but may assist in finding a power source.

Signal time modifications should be considered during planning stages to improve the work zone traffic flow. Field reviews and adjustments during construction should be made as required to improve the traffic flow. Signal head location, timing, detection, and pedestrian volumes should all be considered when making modifications.

Signal timing for temporary traffic signals used to alternate traffic in a single lane consists of the following intervals:

- Green Interval - should be selected to match traffic demand
- All Red and Yellow Intervals - per direction, based on travel speed and distance between stop bars
- Electronic Traffic Control Device Guidelines should be utilized for additional information

The stop bars are typically 50 feet from the temporary signal heads. Adjustment in the field may be necessary to maintain adequate visibility. The duration of the *All Red* Interval (for each direction) can be computed using the following equation:

$$R = \left(\frac{D}{1.47 \times S}\right)$$

Where:

R = All Red Interval (sec)

D = Distance between stop bars **(feet)**

***S* = Speed limit though work zone (mph).**

3.01.04 Interrupted Flow Facilities

The travel time computation for interrupted flow facilities, such as two lane or multilane highways with stop controlled or signalized intersections, should be inclusive of speed delay, queue delay, and control delay.

The complexity of calculating control delay at intersections is magnified when intersection operations are changed within the work zone. This could include a reduction in the number of lanes available, or changes in the phasing of traffic signals. Software tools are recommended to determine travel time for interrupted flow facilities, due to their complexity. Software tools such as Synchro and SimTraffic provide a good estimation of travel time delay during construction.

A. Control Delay Signalized Intersections

The control delay can be estimated by using Synchro, SimTraffic, or manually using the methodology presented in the HCM for work zones with a single isolated signalized intersection. Control delay consists of two components: uniform delay, and incremental delay.

Control delay is computed using the following equation:

$$d = d_1 + d_2$$

Where:

d_1 = uniform delay (sec/veh)

d_2 = incremental delay (sec/veh)

Uniform delay accounts for arrival demand in the subject lane group that is uniformly distributed over time.

The uniform delay **d_1** is computed using the following equation:

$$d_1 = \frac{0.5C(1 - {}^{g}/_{C})^2}{1 - [min(1, X)\,{}^{g}/_{C}]}$$

Where:

C = cycle length (sec);

g = green time for analyzed phase (sec)

X = V/C ratio

The notation **min (1,X)** used in the equation indicates that the smaller of the two values is used.

Incremental delay accounts for random variation in arrivals and delay caused by demand exceeding capacity during the analysis period. The incremental delay **d_2** is computed using the following equation:

$$d_2 = 900T\left[(X - 1) + \sqrt{(X - 1)^2 + \frac{4X}{cT}}\right]$$

Where:

c = lane group capacity (VPH)

T = analysis period duration (hr)

It should be noted that while the equation for incremental delay is purportedly valid for all values of X, including highly oversaturated lane groups, enormous delays will be predicted for situations where X > 1.0 meaning demand exceeds capacity. Therefore, it is recommended that software tools are used to calculate control delay in situations when the computed X > 1.0.

The capacity value for the signalized lane group is necessary for both components of the control delay formula. Each lane group has a different capacity value, depending on the arrangement of turns permitted from the lane group. Capacity values may obtained from Table 3-3.

Example 3.5:
Control Delay Signalized Intersection

A detour of M-20 will add 650 VPH as right turns to a signalized intersection with an existing traffic volume of 200 veh/hr. The lane group consists of a shared left-right-through lane. The signal will be timed for 60% green for the analyzed movement, and the cycle length will be 80 seconds.

Solution 3.5:
Control Delay Signalized Intersection

The lane group capacity is found from Table 3-4 based on 60% green time and unrestricted 12 feet lanes for 100% Turns. The estimated lane group capacity is 870 veh/hr.

The term for g/C is already known to be 60% or 0.60.

The V/C ratio is calculated as:

$$X = \frac{850}{870} = 0.98$$

The term for uniform delay d_1 is

$$d_1 = \frac{0.5 * 80(1 - 0.6)^2}{1 - [0.98 * 0.6]} = 15.5\ sec$$

The term for incremental delay d_2 is computed for the time interval for one hour, thus T = 1 in the following equation:

$$d_2 = 900 * 1\left[(0.98 - 1) + \sqrt{(0.98 - 1)^2 + \frac{4 * 0.98}{870 * 1}}\right] = 45\ sec$$

The total control delay for this lane group is

$$d = 15.5 + 45 = 60.5\ sec$$

B. Travel Time Determination

Similar to uninterrupted flow facilities, the initial travel time (before construction) should be computed or measured. Existing travel time runs may be completed to verify the existing conditions, especially to validate the existing travel time reported from software tools. The travel time estimates may be performed using various techniques summarized in Section 3.03.07 Travel Demand Models and Tools.

3.01.05 Detour Routes

The determination of travel time delay for detour routes includes a comparison of the initial travel time on the original route (before construction) compared to the travel time during construction. The capacity conditions along the detour route will be important to consider, especially regarding the amount of traffic diverted to the detour route. If the detour route consists of traffic signals or other interrupted flow facilities, an evaluation of the intersection operations, including the detour traffic, may be necessary.

For detour routes with the necessary capacity to accommodate the diverted traffic volumes, the travel time along the detour route may be established as the travel distance divided by the average speed. A travel time run may be performed during the design development of the project to establish the anticipated detour travel time. Similarly, the detour travel time may be quickly determined using online map guidance tools, simply placing two points on a map, and routing the path along the detour route.

If intersection control delay is a particular concern for the detour route, the delay may be computed using software tools such as Synchro and added to the previously calculated detour travel time. This level of analysis should be completed when shutting off or detouring a major roadway movement, or the detour route is already at or above capacity, with existing traffic volumes.

3.02 OTHER MEASURES OF EFFECTIVENESS

Other measures of effectiveness such as V/C, LOS or performance measures, may be used to evaluate the mobility of the work zone. These measures can identify choke points or poorly performing features for targeted implementation of mitigation measures. V/C and LOS have been de-emphasized in their specific use for determining the significance of a work zone.

3.03 MOBILITY ANALYSIS TOOLS

Understanding the anticipated type and extent of work zone impacts, aids the development of effective TMPs. Analysis may necessitate the use of software tools depending on the degree of analysis required. Some tools were designed for work zone analysis while other traffic analysis tools, not specifically designed for work zones, can also be useful for analyzing work zone situations. This section discusses various tools available to perform the analyses required to develop and implement TMPs. Contact the WZA for assistance with items in this section or if utilizing tools not included herein.

3.03.01 Construction, Congestion, Cost (CO3) (updated 1/20/2020)

CO3 is a spreadsheet/software tool that estimates the magnitude and impacts of traffic congestion, including cost impacts on road users that can be expected during a construction project. CO3 measures congestion variables such as delay, diverted vehicles, and backup. In addition, a user can estimate and document project costs for alternative methods of maintaining traffic. The program allows for quantification of decreases to demand, such as diversions to alternate or detour routes.

MDOT provides additional information regarding the CO3 software including the most recent spreadsheets, user manual, and updated user cost inputs. These resources are available on the MDOT website: CO3 Spreadsheets and User Manual

CO3 is used in Michigan to estimate delay and user cost for work zones on uninterrupted flow facilities and traffic regulator operations. The program requires hourly traffic data inputs throughout the day which should be readily available at TDMS. The program allows the work zone capacity to be inputted for each hour of the day. An example summary view of the spreadsheet output is located in the Appendix B: Mobility Analysis Tools.

A. Important Notes Regarding CO3 Inputs

1. The “method travel distance” and “normal travel distance” are usually the same for a work zone which is open part width or with a route around (i.e. crossovers on a freeway). The only exception to this rule, is a full closure.

2. Inputs for “diversion” should be considered in context of a voluntary alternate route. The analyst should seek input from MDOT BTP, Region or TSC to determine an appropriate diversion rate.

3. The “normal travel speed” should be the existing posted speed limit. Speed delay calculations are always made in comparison to this number.

4. The speed delay threshold and range values should be entered for work zones that operate with a reduced speed limit at all times, and a lower speed limit during active work periods

(i.e. 45 mph where workers present and 60 mph at all other times).

5. If only speed delay threshold values are filled in, then any time period with a capacity above this threshold will operate at the normal travel speed (i.e. 60 mph during working periods and 70 mph at all other times).

6. The speed when D~0, and speed, when D=C, values should be determined using the CO³ Common Inputs sheet.

7. The adjusted capacity must be calculated using the method described in Section 3.01.02 A.

8. For work zones with hourly lane closure restrictions, the capacity may be modified to accurately reflect the capacity for each time period.

9. For training needs and additional questions please contact the WZA.

10. The MDOT website for C03 has a number of resources that provides additional information and details on the required inputs.

3.03.02 Synchro and SIM Traffic

Synchro and SIM Traffic programs are frequently utilized by MDOT for signal timing and geometric design evaluations. Many validated network models exist and may be utilized for work zone evaluation. Outputs include travel times, levels of service, and other measures of effectiveness.

3.03.03 Synchro

Synchro is a macroscopic capacity analysis and optimization model which performs a straight-forward analytical capacity analysis allowing users to get a measure of delays, queues, etc. based on equations.

Synchro also optimizes signals in a network and uses the intersection capacity utilization method to determine capacity for signalized and un-signalized intersections. It supports the HCM methodology and is recommended for determining the travel time on interrupted flow facilities.

A. Important Notes for using Synchro for Signalized Work Zones:

1. Between the existing scenario and the temporary configuration, the geometry must be updated to reflect the available lanes.

2. Any adjustments to traffic volumes or signal phasing and timing should be documented and applied where appropriate.

3. The *Link Speed* input should be set to represent the work zone posted speed limit. Synchro uses *Link Distance* and *Link Speed* to determine the *Running Time*.

4. The Arterial LOS report can be used to summarize travel time for a work zone treated as an arterial street. The LOS analysis provides a high level analysis and maybe used for planning and scoping purposes. Several dummy nodes must be added to the network to represent the boundaries of the work zone, since running time is only reported between signalized intersections. The dummy nodes can be coded for 100% green time which represent the entrance and exit for the work zone.

5. The summation of running time and signal (control) delay results in the Travel Time. This value should be compared with the existing scenario to determine the travel time increase predicted for the work zone.

3.03.04 SIMTraffic

SIMTraffic is a microscopic simulation model that simulates signalized and un-signalized intersections (including roundabouts) and the interaction that occurs between intersections.

A. Important Notes when using SIMTraffic for Signalized Work Zones:

1. The results of the SIMTraffic Arterial LOS report may differ from those presented in the Synchro report.

2. The SIMTraffic analysis includes several parameters that should be adjusted to simulate the intersections.

3. This microscopic Arterial LOS is recommended for significant and potential significant projects to identify operational issues.

4. Information for calibrating the SIMTraffic model is provided in MDOT's Electronic Traffic Control Device Guidelines.

3.03.05 Highway Capacity Manual (HCM) and Highway Capacity Software (HCS)

The Highway Capacity Manual (HCM) is a reference document that contains concepts, guidelines, and computational procedures for computing the capacity and LOS on various facility types. The HCM can be used for both planning and operational analyses. A planning analysis gives measures of effectiveness such as time delay, average travel speed, LOS and V/C ratios. An operational analysis allows for diagnosing, testing, and designing mitigation measures.

Highway Capacity Software (HCS 2010) is a package of modules to implement the HCM procedures to compute capacity for various facility elements such as intersections, segments, and ramps. The software is macroscopic in scope and provides outputs with limited data input.

This software is used in Michigan to evaluate capacity situations for independent facility elements such as an entrance ramp merge point, or a stand-alone intersection. For traffic signal evaluation, Synchro is recommended.

3.03.06 PTV-VISSIM (Planung Transport Verkehr) Vissim (Verkehr In Städten – SIMulationsmodell)

PTV-VISSIM is a microscopic, time-step and behavior based simulation model developed to analyze roadways and transit operations. VISSIM simulates urban and highway traffic including pedestrians, bicyclists, and motorized vehicles. VISSIM can model integrated roadway networks found in a typical corridor as well as various modes consisting of general-purpose traffic, buses, HOV lanes, high occupancy toll lanes, rail, trucks, pedestrians, and bicyclists. Changeable message signs, ramp metering, incident diversion, transit signal priority, lane control signals, and dynamic lane control signs can also be modeled with VISSIM.

Note: VISSIM is data intensive and requires special expertise. It should be limited to situations in urbanized areas where impacted roadways are typically at capacity. The model requires graphical coding of a network and calibration variables. Additional information regarding this program and variables can be obtained from the MDOT Congestion and Mobility Unit.

3.03.07 Travel Demand Models and Tools

A. TransCAD

TransCAD is a Geographic Information System (GIS) based software tool used to implement travel demand modeling. Using the four-step transportation modeling process and TransCAD software, travel demand models are used to identify existing and future highway capacity deficiencies and analyze potential improvements. Travel demand modeling refers to the development of a series of mathematical relationships, specifically designed to simulate existing and forecasted travel patterns.

Travel demand models have been developed for large urban areas in Michigan for the governing MPO. A statewide model has also been developed to evaluate alternatives outside of urban area boundaries. Travel demand models replicate existing traffic, the effects of impedance to that traffic, and where and when future congestion will occur. They can also estimate the impact of congestion in terms of changes in the LOS or the amount of delay saved from future transportation improvements. This allows a comparison of the benefits of various transportation projects.

In complex situations or for high impact projects, these models should be used to evaluate the diversion of traffic from work zones due to lane closures or other impedances as well as identify routes that will be impacted by the work zone. The output from the travel demand model can be used to justify diversion rates used for alternate routes.

B. DynaSmart-P

DynaSmart-P is a dynamic traffic assignment analysis tool that may be used for regional work zone management. This program combines dynamic network assignment models used primarily with demand forecasting procedures for planning applications, and traffic simulation models and are, used mainly for traffic operations studies.

Potential applications include; assessing the impacts of alternate traffic control strategies for work zones, incidents, and special event management, and assessing the impacts of ITS technologies on the transportation networks. In addition, DynaSmart-P can evaluate congestion-pricing schemes for toll roads and produce traffic operations data for air quality analyses.

C. Regional Integrated Transportation Information Systems (RITIS)

RITIS is a tool used to compile, analyze, and archive speed and travel time data. RITIS includes many performance measures, dashboards, and visual analytics tools that help agencies gain real-time situational awareness, measure performance, and communicate information between agencies and the public.

RITIS utilizes real-time data feeds and automatically compiles and standardizes data obtained from multiple agencies to provide an enhanced overall view of the transportation network. Users can filter information specific to their project, road, or regional area. The RITIS tools allow users to identify incident hot-spots, analyze queue lengths and traffic congestion/bottlenecks, monitor speed and delays caused by incidents, work zones, weather, events, and other causes, and evaluates the effectiveness of transportation operations strategies. Agencies are able to view transportation and related emergency management information and use it to improve operations and emergency preparedness.

Data within RITIS is archived and may be downloaded exported to perform independent analyses. MDOT uses RITIS for before and after analysis of construction projects to aid in determining the effectiveness of the project on traffic operations. RITIS may also be used to provide information to third parties, the media, and other traveler information resources. Information about the tools within RITIS is available at: https://www.ritis.org/tools

Access to RITIS may be requested through the MDOT Project Manager. MDOT employees may gain access at no cost by visiting https://www.ritis.org/register/. A login ID is NOT needed to view reports generated within RITIS.

CHAPTER 4

WORK ZONE SAFETY

4.01 GENERAL

Work zones can create safety impacts. Different projects have different needs and the same levels of mitigation strategies are not appropriate for every project. When considering work zone management strategies that mitigate safety and mobility issues, it is important to consider constructability, cost and time.

Work zone management strategies are developed based on project characteristics through a detailed analysis of relevant information.

Examples of items to consider include:

- Traffic volume and roadway capacity
- Network availability (alternate routes)
- Traffic / user access
- Local and regional traffic impacts
- Project schedule/time (work days, work hour restrictions, critical work/material time, seasonal issues)
- Project site conditions (utilities, slopes, objects, drainage, etc)
- Project work operations (access, hauling)
- Project purpose and features (road encroachment impacts)
- Safety assessment (crash rate, workers, and road users)
- Previous projects in the area (performance assessments)

Construction needs to be accomplished while accommodating safety and mobility; ensuring worker and motorist safety.

Safety and mobility impacts are not restricted to the work zone location. They also include the construction influence area and adjacent or overlapping projects. Coordination between projects is necessary and should be addressed in the TMP. Strategies may need to be justified as MOT costs escalate.

A benefit cost analysis comparing road user costs to increased construction costs should be performed when multiple options are feasible. Safety benefits may be challenging to quantify but should be factored into the project design. Safety and mobility impact mitigation strategies are presented in more detail throughout this chapter.

4.02 CONSTRUCTION AND CONTRACT METHODS

The WZSM Policy ensures all work zone impacts are appropriately identified, mitigated, and managed on a systematic basis. Work zone and traffic management design strategies should provide the highest level of safety, mobility, and constructability.

A total road closure may be the best example of this approach. Generally, this is the safest, most mobile and constructible work zone approach. Workers and road users are separated and exposed to fewer hazards, road users are not delayed through a restrictive work zone, and construction

may proceed without accommodating traffic.

A full closure may be a desirable starting point for some projects based on the project specifics. The time is dramatically reduced, and safety and overall quality of the project are improved. However not all project are candidates for this strategy for a number of reasons:

- Lack of alternate route capacity
- Lack of adequate detours
- Severe congestion throughout a widespread area
- Local traffic access to residences and businesses
- Other traffic management and cost issues

A more common and acceptable approach is a combination of short-term closures and partial width stages. This strategy uses a TTCP that positively separates and protects workers and road users, while accommodating efficient work operations and traffic mobility.

Some projects may benefit from efficiently staged and protected work operations versus routine lane closures that close and open each day.

When developing the TMP it is important to consider the constructability of the project based on the preferred MOT scheme. A TMP should be developed in conjunction with the construction staff to ensure projects are buildable and safe. This includes reviewing work schedules, production rates, and industry means and methods. If the preferred MOT places too many restrictions and limitations on constructability, there may be negative consequences to the costs and quality. Several construction and contracting strategies are listed in Chapter 2 Transportation Management Plan.

It is important to remember there are practical limits to work zone strategies. Mobility and safety benefits that are relatively short term may not be practical if the cost of implementation offsets a significant portion of the benefit. Some projects may benefit from a wider review and discussion on possible work zone strategies, such as:

- Value Engineering Study
- Constructability Study
- Industry plan reviews
- Work Zone Construction Peer Review
- Maintenance of Traffic Meetings
- Traffic Survey/Study
- Innovative contracting
- Governmental agency and special event coordination meeting

Constructability is a key element in a successful work zone strategy. Issues of material selection, production rates, and work operation efficiencies have a direct tie to the feasibility of the strategy. The following successful strategies have been implemented:

- Short duration closures (weekend, week, or a combination)
- Continuous weekday closure
- Weekend closure
- Nighttime and weekend lane closures

- Rolling 15-min short term freeway closures

These strategies use specific materials such as quick-curing concrete, accelerated work schedules, prefabricated structure components, on-site mix plants, etc., and are based on actual production rates. Work zone strategy development is a dynamic process that continues as project information and design features are developed. There may be many factors involved with strategy development.

FHWA provides additional guidance and a comprehensive table of work zone impact management strategies to consider in the development of a TMP.

FHWA document links:

- Developing and Implementing TMPs (TMPs) for Work Zones
  - FHWA Document Section 4.0
  - FHWA Document Appendix B

MDOT also provides a best practice folder which may be found on ProjectWise (TMP Best Practices). For access to this folder please contact the WZDE.

4.03 WORK ZONE CONSIDERATIONS

Work zones should be planned and designed to consider work operations and address safety impacts for workers, traffic regulators, motorists, and non-motorized users.

4.03.01 Work Zone Hazards

Each work zone should be assessed for hazards. The following provides a list of example conflicts for drivers, workers, and traffic regulators that designers should consider when developing the TTCP:

- Congestion related crashes
- Work zone crashes & crash patterns
- Roadway configuration, merging tapers and lane drops
- Unexpected queues
- Unstable traffic flow
- Lane widths
- Pavement markings
- Clear zone safety issues
- Drainage
- Lane departures
- Barrier wall and attenuation
- Roadway geometrics
- Vertical hazards, drop offs
- Emergency vehicle access
- Disabled vehicle refuges
- Night work visibility
- Confusing or conflicting signs, markings and features

Designers should also consider the following conditions for workers and traffic regulators when developing a work zone TTCP:

- Work zone protection
- Impaired or distracted drivers
- Errant vehicles
- Narrow work zones

- Equipment and materials storage
- Escape routes for workers
- Exposure to moving equipment
- Aggressive drivers
- Speeding drivers
- Vehicle crashes and crash patterns
- Work zone access (ingress / egress)
- Pedestrians/Non-motorized Traffic
- Shared use trails and paths

4.03.02 Workers

The most common cause of injury to workers is construction equipment within the work zone.

Drivers experiencing long delays become impatient and can act unpredictably increasing worker exposure. Other driver conditions to consider include:

- Impaired drivers
- Drowsy drivers
- Distracted drivers
- Aggressive drivers

Designers should also take into account the position of the workers behind barrier walls. Unless the wall is secured to the pavement or has limited deflection, consideration should be given to improving or creating a lateral buffer space.

Barrier protected work zones should be considered on a project-by-project basis and not just for long term stationary projects.

In addition to the location of the workers and their proximity to traffic, the type of work taking place should be factored into the design of the TTCP.
Active work should not take place with traffic on both sides of the workers, on the same roadbed, unless there is positive protection. Traffic can be on both sides of a lane closure for concrete curing when no workers are present.

A. Traffic Regulators and Spotters

Traffic regulators are typically used to stop and direct traffic for work activities such as:

- One lane alternating traffic control
- Intersection control
- Road closures (Parades, Special Events, etc.)
- Short durations
- Spot locations
- Ingress and egress Locations

A spotter may be used to watch traffic and alert workers of an approaching errant vehicle.

The following are some TTCP considerations:

- Evaluate the necessity of using traffic regulators at night. If determined that traffic regulating is the most effective option for the TTCP, the engineer should review and approve the lighting plan and layout prior to the start of construction. Balloon Lighting is required for traffic regulator stations.
- Traffic regulators must not be utilized on freeways at any time. Haul road crossing may require a traffic

regulator and should be reviewed and approved by the project office.

- The traffic regulator's location, escape route, protection and other safety related issues should be incorporated into the traffic regulator station.

- Law enforcement may be used for some traffic regulator operations.

- Spotters may be used to decrease worker exposure when applicable. Intended spotter locations should be shown on the TTCP.

Detailed information on traffic regulator procedures and conduct is available through the resources included in Appendix G (Resources).

4.03.03 Road Users (updated 1/20/2020)

The message conveyed to the user through signing, pavement markings, and devices must be concise and consistent.

A. Drivers

Drivers and their passengers account for more than 90% of work zone fatalities. It is important to provide a TTCP that effectively guides and protects drivers while traveling through the work zone. Effective planning and design of work zones should be considered from the driver's perspective.

To provide adequate time to react and make rational decisions to navigate safely, the work zone impact mitigation strategies should be easily understood by motorists.

Temporary channelization and alignment should be modified to the work zone conditions. MDOT work zone guidelines and typicals should be followed; however modifications that improve the safety and operations of the work zone should be made according to field conditions. Changes should be documented in the *Inspector's Daily Report* (IDR).

The riding surface is important for the safety of motorcycle riders. Whenever possible, construction operations should be avoided that place motorcycles on grooved pavement, pavement lane edge drops from milled surfaces, rumble strips and unpaved surfaces. If these conditions cannot be avoided, the TTCP should include adequate warning signs for these conditions to alert the motorcycle riders. Consideration should also be made for ingress/egress points, where designs should include the capability of a motorcyclist accessing the roadway perpendicular to differentials in pavement elevations.

B. Non-motorized Users

Adequate facilities should be provided to allow non-motorized users to travel through or around the work zone. Requirements and guidance on maintaining non-motorized user traffic in work zones are found in Chapter 5 Non-Motorized Work Zone Mobility.

C. Oversized Vehicles

If the TTCP for the proposed work zone does not allow vehicles that exceed the legal width, height or weight limits, notify the region/TSC transport permit agent. Warning signs notifying vehicles of the restriction must be provided. On some projects, it may be necessary to designate a detour route for oversized vehicles.

4.03.04 Work Zone Crash Reduction Strategies and Mitigations (updated 1/20/2020)

According to the *MDOT Trunkline Crashes in Work Zones Report (2012)*, the five primary crash types in work zones are:

- Rear-end straight (RE-ST)
- Sideswipe-same direction (SS-SM)
- Fixed object (FXOBJ)
- Other object (O-OBJ)
- Angle-straight (AN-ST)

The five primary crash types have accounted for approximately 80% of trunkline work zone crashes from 2002 to 2014. Each type may be related to several work zone factors. Potential crash reduction strategies for the TTCP design and during construction are shown in the tables below. Please contact the WZDE for additional methods or option details.

TABLE 4-1: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: REAR END CRASHES

Work Zone Crash Factors	Crash Reduction Strategy	Crash Reduction Tools
Speed	Review Work Zone Speeds	• Single, Double, or Triple speed limit step downs
	Additional devices	• Temporary rumble strips • Flashing speed limit signs
	Uniformed Law Enforcement Presence	Use law enforcement to alert motorists of work zone queue
Geometry	Review Work Zone Lane Closure / Shift Tapers	• Work Zone Audit Report (Form 0397) • Drive thru work zone after initial setup and stage changes • Verify work zone taper lengths
Access	Review ingress and egress of work zone vehicles	• Internal Work Zone Traffic Control Plan • Add signing (Truck Entrance /Exit Ahead, Truck Crossing) • Add acceleration / deceleration area for trucks
	Signing for work zone ingress and egress locations	• Turn restrictions at driveways and access points
Capacity / Congestion	Additional warning for motorists	• Dynamic Message Signs • PCMS • Queue Detection Systems • Dynamic Lane Merge System • Rumble Strips (transverse prior to work zone) • Additional Global Signing • Travel time information signs
	Accelerated construction techniques; working / lane closure time restrictions	• Night work • Off-Peak work • Switch to full closure • Use lane / ramp rental or liquidated damages special provisions
	Minimize number of stops / delay improvement	• Temporary signal timing coordination • Adjust signal phasing and splits • Add turn lanes and/or passing flares • Close crossovers or alternate intersections • Close on / off Ramps
	Alternate Route	• Alternate Route Signing Plans • Traffic signal optimization along alternate route
	Review MOT staging, look at ways to add lanes (capacity)	• Moveable barrier • One-way detour • Temporary Widening • Split Merge
Geometry	Review sight distance and operation at intersections and driveways within the work zone	• Turn restrictions • Decrease device spacing • Gap for approaches • Worker Vehicle Equipment Location

Delineation and Signs	Additional warning signs for approaches and high traffic volume driveways	• Add temporary signing for approaches i.e., W2-1, W2-2, W2-3
	Review work zone devices at intersections and driveways within the work zone	• Decrease device spacing • Gap for approaches • Review barricade locations - do not interfere with intersection sight distance

TABLE 4-2: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: SIDESWIPE- SAME DIRECTION CRASHES

Work Zone Crash Factors	Crash Reduction Strategy	Crash Reduction Tools
Speed	Review work zone speeds	• Single, Double, or Triple speed limit step downs
	Intelligent Transportation System (ITS) speed warning signs	• Flashing speed limit signs • Increase law enforcement
Geometry	Increase lanes and/or shoulders widths, where possible	• Separate truck lane • Parking restrictions
	Review Traffic Shift and Lane Closure Taper Lengths	• Work Zone Audit Report (Form 0397) • Verify taper lengths • Verify proper sight distance to closure
Delineation and Signs	Review configurations for Yield, Merge, or Acceleration Lanes	• Temporary application of Geometric Design Guide, if possible • Remove when work is complete
	Review travel path delineations	• Temporary rumble strips
	Additional signs for traffic merge / shift locations	• Add warning signs (i.e., W11-24) • Dynamic Lane Merge System • Add R4-9 Signs (Stay In Lane)
	Add delineations	• Channelizing devices and/or temporary barriers
	Pavement markings	• Solid temporary pavement markings (no temporary skips) • Increase pavement marking reflectivity • Temporary raised pavement markings

TABLE 4-3: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: FIXED – OBJECT CRASHES

Work Zone Crash Factors	Crash Reduction Strategy	Crash Reduction Tools
Work Zone Speed	Review work zone speeds	• Single, Double, or Triple speed limit step downs
	ITS speed warning signs	• Flashing speed limit signs
Delineation and Signs	Place object markers at fixed object locations near travel path	• Temporary reflector • Temporary attenuator
	Add delineation	• Channelizing devices • Temporary delineators
Fixed Object Location	Remove, relocate, or protect fixed object	• Temporary guardrail • Temporary concrete barrier

TABLE 4-4: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: OTHER OBJECT CRASHES

Work Zone Crash Factors	**Crash Reduction Strategy**	**Crash Reduction Tools**
Delineation and Signs	Frequent inspection and review location and placement of temporary devices (signs, drums, barricades, channelizing devices, etc.)	• Work Zone Audit Report (Form 0397)
	Delineate travel path from objects and devices	• Ensure Lighting for Night Work requirements **12SP-812CC-01**, **12SP-812DD-01** • Review pavement marking • Temporary delineators
Speed	ITS speed warning signs	• Flashing speed limit signs
	Review work zone speeds	• Single, Double, or Triple speed limit step downs

TABLE 4-5: WORK ZONE CRASH REDUCTION STRATEGIES AND TOOLS: ANGLE CRASHES *(ADDED 1/20/2020)*

Work Zone Crash Factors	Crash Reduction Strategy	Crash Reduction Tools
Signal and ITS	Advance warning flashers	• Add advance temporary intersection or Signal Ahead warning signing with flasher
	Review signal head placement and timing	• Ensure correct signal head placement over lanes • Cover or bag any conflicting information • Check signal corridor timing
Geometry	Review turning movements	• Add left turn lanes or limit left turns • Create right turn pocket with devices
	Review intersection and stopping sight distance.	• Ensure construction materials and equipment are not blocking sight distance. • Verify intersection and stopping sight distance
Delineation and Signs	Additional advance intersection signing	• Add lane assignment signs (R3-8 series) (ground mount & overhead) • Add No Left/Right turn signing (R3-1, R3-2) • Add advance intersection (W-2 Series), signal ahead (W3-1), or stop ahead (W3-1), warning signs
	Review travel path	• Verify taper / shift lengths
	Pavement markings & advance warnings	• Temporary stop bars, and crosswalks • Lane assignment arrows on pavement • Temporary rumble strips • Solid temporary pavement markings leading up to stop bars

4.04 WORK ZONE TRAFFIC INCIDENT MANAGEMENT (TIM) CONCEPTS

Work zone TIM involves monitoring traffic conditions and making adjustments when traffic incidents (unplanned events) occur in the work zone. TIM involves deploying technology, establishing procedures and policies, and implementing systems for improving the detection, verification, response, and safe quick clearance of events when they occur in the work zone and on associated detour routes.

A work zone TIM program provides specialized techniques for detecting, verifying, responding to and clearing traffic incidents in work zones.

The congestion and delays in and around work zones can come from vehicle crashes and breakdowns. As congestion builds, work zone crash rates can increase. TIM can help reduce the time required to clear incidents in and around work zones. This results in a reduction of traffic congestion and delay, making the area safer for those working to clear the incident. The longer the incident is active, the higher the chance/rate of a

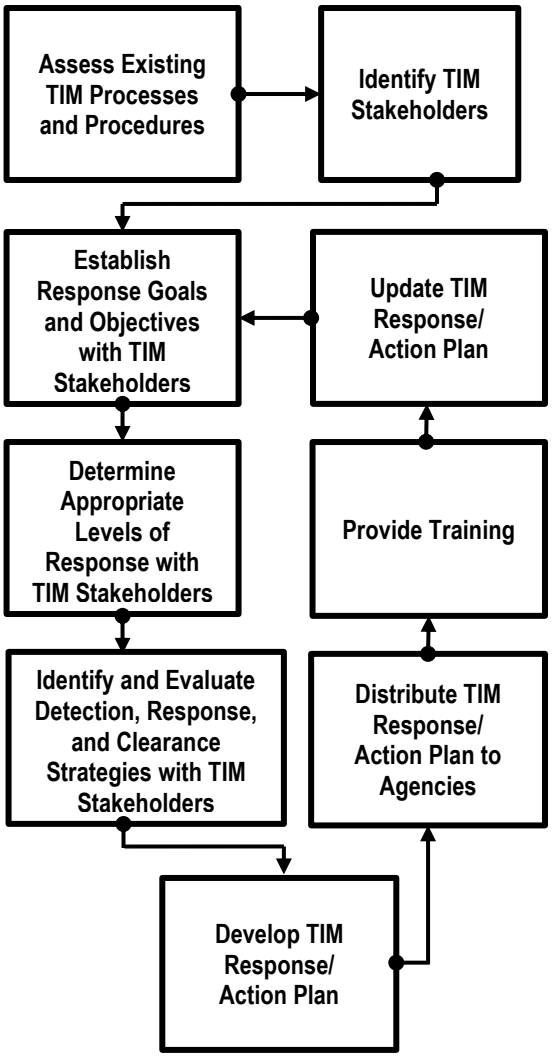
secondary incident. A secondary incident is often more severe than the primary. The TTCP and TOP should include mitigation measures and strategies for TIM.

The steps involved in the development of a TIM plan for construction projects to mitigate the impact of traffic incidents are summarized in **Exhibit 4-1**.

4.04.01 Assess Existing Processes and Procedures

TIM programs and processes have been established in most regions. Using the existing TIM processes and procedures in the work zone is the first step to developing TIM for the construction project. Verify whether the construction project is within the jurisdiction of an existing incident management program and coordinate with MDOT region/TSC/TOC and first-response personnel.

EXHIBIT 4-1:
WORK ZONE TIM DEVELOPMENT PROCESS



4.04.02 Planning and Design

TIM strategies appropriate for the type of work zone should be developed, identified, implemented, and detailed in the TMP.

A. Identify Stakeholders

Incident management programs are successful when they are built on a foundation of cooperation and collaboration. It is essential that work zone TIM includes coordination with the incident responders within the area. This includes identifying and meeting with agencies to discuss current response policies, procedures, and practices.

The following is a list of potential agencies and organizations traditionally involved in the region TIM programs:

- MDOT and local transportation agencies
- State and local law enforcement
- Fire and rescue agencies
- Regional, county, and local 911 dispatch
- Towing and recovery providers
- Emergency medical service providers
- State and local hazardous material recovery personnel
- Medical Examiners or Medical Examiner Investigators
- Emergency Management
- Media
- Contractor
- Other response personnel in the project area
- Sovereign Nation

B. Establish Response Objectives and Procedure Guidelines

Objectives and procedures for incident responders in a work zone should be established when developing the TIM strategies for the construction project. Different stakeholders involved in the project may have different goals and objectives. The following list provides some objectives for developing work zone TIM and should be included in the TMP:

- Minimize detection, notification and verification times; number of closed lanes; length of exposure; motorist delay; response time of emergency services;
- Maximize the use of existing communication resources; safety of responders and travelers; information sharing and coordination among agencies;
- Provide timely, accurate information to the public enabling them to make informed decisions

Procedures may also be developed for how and when certain TIM functions should be performed in a work zone. Standard documentation for TIM response/action plans should be maintained by each TOC or TSC, and should be discussed with project staff and the TOC prior to the start of the project.

Procedure guidelines for traffic incidents in work zones may be needed for:

- Notifying other emergency responders
- Managing the scene
- Moving damaged or disabled vehicles and debris
- Closing and opening lanes
- Disseminating information to travelers and media
- Implementing alternate / emergency routes

C. Determine Appropriate Levels of Response

Each strategy and incident scenario should be evaluated by agencies to determine the appropriate level of response for each type of traffic incident. The MMUTCD Part 6 I *Control of Traffic Through Traffic Incident Management Areas*, divides incidents into three classes based on duration, each of which has unique traffic control characteristics and needs.

1. **Major** - typically includes traffic incidents involving hazardous materials, fatal crashes, and disasters. These traffic incidents involve closing all or part of a roadway facility in excess of two hours.

2. **Intermediate** - affects travel lanes for 30 minutes to two hours, usually requiring traffic control on scene to divert road users, full roadway closure may be needed for short periods**.**

3. Minor - Affects all or parts of the roadway for less than 30 minutes. Typically includes disabled vehicles and minor crashes. On scene responders are typically law enforcement and towing companies.

D. Identifying and Evaluating Detection, Response, and Clearance Strategies

Strategies for detecting, responding to, and clearing incidents from the roadway are summarized below. Additional information may be found in the FHWA document, Traffic Incident Management in Work Zones.

1. **Detection –** Several strategies commonly used to improve incident detection are**:**

   - Permanent Cameras and Detection
   - Temporary Portable Cameras
   - Stopped Traffic Advisory System
   - Portable Traffic Detector/Sensors

   More details can be found in Section 6.06 Work Zone Intelligent Transportation Systems (ITS) and Technology

2. **Response -** Strategies commonly used to improve work zone TIM response, are summarized below:

   - Dedicated Response Vehicles / Freeway Courtesy Patrol
   - Emergency Personnel Resource List
   - Equipment and Material Resource Lists

3. **Safe Quick Clearance -** Safe Quick clearance strategies for improving traffic incident clearance in work zones are summarized below:

   - Emergency Pull Off/Vehicle Refuge Areas
   - Crash Investigation Sites
   - Wrecker Service Special Provisions
   - Emergency Turnarounds/Access Gates
   - Dedicated Service Patrols
   - Alternative Emergency Response Access Routes
   - Predefined Staging Areas for TIM Personnel
   - Traffic Responsive Signal Control Plans

MDOT region/TSC personnel, construction staff, and emergency responders should *together* review the construction activities to ensure the response procedures and communication plans are appropriate.

A. Develop and Distribute Response/Action Plan

A response or action plan should be developed to depict what types of responses may be necessary for different levels of traffic incidents that may occur in the work zone. The response plan needs to be distributed to appropriate TIM stakeholders and project staff should ensure that it is disseminated to appropriate response and field personnel.

The emergency response procedures and practices in a work zone should remain valid and up-to-date for all phases of construction.

B. TIM Training

Training is an important aspect of developing and implementing a work zone TIM plan. Please visit the MI-TIME website to request training.

4.05 WORK ZONE LAW ENFORCEMENT (updated 1/20/2020)

Notify RennerL1@michigan.gov when adding to projects work zone law enforcement to projects. The process for work zone law enforcement is currently being revised.

Work zone enforcement can be an effective tool to alter or improve motorist behavior when entering or traveling through a work zone. Examples include:

- Visible presence - this application affects a large percentage of motorists as law enforcement is on-site.
- Active enforcement - is used in close proximity of workers, where lower speeds are in effect. This type of enforcement enhances work zone laws and regulations regarding motorist behavior.
- Additional Work Zone Enforcement - typical applications include working within the roadway when an active traffic signal is present or traffic stoppages are occurring. This type of traffic control should be limited to short periods of time. For longer work durations, it is best to provide other types of traffic control.

Work zone enforcement should be determined during project scoping, prior to the project start up, and as needed throughout the project. TSC personnel

should meet with all applicable enforcement agencies for the project to discuss enforcement expectations.

High visibility apparel is required for law enforcement when engaged in work within the right-of-way (routine traffic stops are excluded). When performing routine traffic stops within the construction influence area, high visibility apparel is recommended. High visibility apparel must meet, at minimum, the American National Standards Institute and the International Safety Equipment Association (ANSI/ISEA) 107.2004 standard Class 2 performances or the ANSI 207.2006 standard.

Region and TSC staff should engage the local law enforcement jurisdictions each season to enhance safety in all maintenance, construction and permitted activity work zones. Regions and TSCs should prioritize projects for uniformed law enforcement presence based on specific project safety and mobility needs.

The following strategies should be considered when prioritizing uniformed law enforcement:

- Frequent worker presence adjacent to high-speed traffic without positive protection devices.

- Traffic control set-up or removal activities that present high risks to workers and road users.

- Complex or short term changes in traffic control patterns with potential for road user confusion or high risk worker exposure to traffic.

- Night work operations that have complex MOT methods.

- Existing traffic conditions and crash histories that indicate a potential for substantial safety and congestion impacts related to the work zone, which may be mitigated by improved driver behavior and awareness of the work zone.

- Construction operations that require brief stoppage of all traffic in one or both directions.

- High-speed roadways when unexpected or sudden traffic queuing is anticipated, especially if the queue forms a considerable distance in advance of the work zone or immediately adjacent to the workspace.

4.05.01 Agreements, Documentation & Strategies (updated 1/20/2020)

The process for work zone enforcement is currently under revision. Notify the RennerL1@michigan.gov when utilizing work zone law enforcement.

CHAPTER 5

NON-MOTORIZED WORK ZONE SAFETY AND MOBILITY

The MMUTCD Chapter 6D provides the requirements and guidance for non-motorized traffic accommodations in construction and maintenance work zones, as well as for work performed under permits. As stated in the MMUTCD:

> *"The needs and control of all road users (motorists, bicyclists, and pedestrians within the highway, or on private roads open to public travel), including persons with disabilities (in accordance with the Americans with Disabilities Act of 1990 (ADA), Title II, Paragraph 35.130) through a TTC zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents."* (Michigan Manual of Uniform Traffic Control Devices, 2011, p. 547 Part 6)

The chapter provides additional information specific to the planning, scoping, design, and implementation of non-motorized traffic control.

5.01 DEFINITIONS

5.01.01 Pedestrian Facilities

Pedestrian facilities are improvements and provisions that accommodate or encourage pedestrian mobility. Such facilities may be temporary or permanent and include but not limited to:

- Sidewalks
- Crosswalks
- Curb ramps
- Traffic Control Devices
- Grade separations (overpasses, underpasses, and structures)
- Shared-use / side paths
- Design features intended to encourage pedestrian mobility, such as:
    - Traffic calming devices
    - Center refuge islands

5.01.02 Bicycle Facilities

Bicycle facilities are improvements and provisions that accommodate or encourage bicycling. Such facilities may be temporary or permanent and include but are not limited to:

- Exclusive bikeways (bicycle lane/cycle track)
- Shared-use / side paths
- Marked shared lane
- Protected bike lanes
- Paved shoulders ($\geq$ 4')

5.01.03 Recreational Facilities (Future)

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5.02 DESIGN CONSIDERATIONS

Existing non-motorized activity should be evaluated during the scoping and planning phases to plan for pedestrian and bicyclist needs during construction. This information will be used in the development of the TMP. Additional information regarding the project

development process is provided in Section 1.02 Process.

Non-motorized response to signing, pavement markings, and other traffic control devices is often different from vehicular responses. Pedestrians and bicycles are more likely to follow their desired path and ignore long alternate routes. The physical space available for mitigating pedestrian impacts is often limited.

Mitigation should occur within the proposed right-of-way (ROW). If that cannot be accomplished, early notification to obtain additional ROW or to assess alternatives is critical to the schedule and budget of the project. If the closure meets standards and no viable alternatives exist, closing a non-motorized route may be an acceptable alternative.

Per the MMUTCD section 6G.05 *"where pedestrian routes are closed, alternate pedestrian routes shall be provided."* The level of detail required for the alternate route should be based on guidance given in this section and can range from something as complex as providing a licensed transportation shuttle, to something as simple as providing advance warning as in the MMUTCD Typical Application - 28.

A. Environmental Clearance

Projects must be reviewed for environmental clearance and have form 1775 or 2242 completed. When determining a location for a detour or alternate pedestrian route the details are required to be in form 1775 or 2242. For any additional environmental clearance questions, contact your Environmental Clearance Coordinator or the Environmental Services Section.

B. Site Review

The site review should include an assessment of the existing pedestrian facilities for impacts relative to the project. ROW impacts should be documented during the site review. Pedestrian and bicyclist volumes are frequently low and not readily obtained. Indications that these activities do occur within the work zone include:

- Existing sidewalk, trail, or pathway
- Observed pedestrian activity
- Evidence of pedestrian activity (i.e. worn paths along the roadway)
- Area traffic generators (i.e. commercial or institutional land uses near residential areas and transit stops).
- Dedicated bike lanes/bike route

The site review should assess the nature and scope of activities, potential safety, and capacity concerns along with alternative routes where appropriate.

In addition, non-motorized traffic generators should be documented and reviewed. Generators that may require additional attention are schools, shopping centers, and local street side businesses. ADA considerations must also be evaluated for every project. In certain locations, an engineering study of the non-motorized traffic may be required to determine the impact the project will have on the local population. It is important to note any ROW impacts found either during the scoping process or the preliminary review.

C. Data Collection

The required analysis to be conducted and the data collection necessary will vary depending on the type of project and location. In low volume areas, a site review may be sufficient to assess the relative number of pedestrians and the pattern of their movements. In urban, suburban, and rural areas with tourist

activity, it may be necessary to collect more detailed pedestrian and bicycle count data including:

- Classification counts
- Speed survey
- Origin-destination information
- Intersection control &and signal timing
- Adjacent land uses

Pedestrian data may be available from a number of existing sources:

- MDOT's Transportation Data Management System (TDMS)
- Past Traffic Signal Optimization Projects
- Existing Traffic Impact Studies
- Regional and Local MPO

Past traffic signal optimization projects may provide the majority of information if the intersection is signalized. This data is typically limited to peak hours.

If existing data is not available, field counts are preferred. If trip generation rates are available, they may be used to estimate the pedestrian activity through the work zone. Typical pedestrian and bicycle traffic generators include:

- Residential housing
- Shopping centers
- Churches
- Shelters / rescue missions
- Schools
- Universities / Colleges
- Daycare centers
- Senior centers
- Retirement communities
- Community centers
- Stadiums / Arena
- Parks and beaches
- Dedicated bicycle routes
- Central business districts
- Transit/school bus routes
- Sporting, Special Event and concert venues

D. Feasibility Analysis

A formal mobility analysis is not required, a feasibility analysis should be conducted if there are more than 10 pedestrians per hour in the peak hours. The surrounding pedestrian traffic generators should be reviewed as pedestrian peak hours may not coincide with vehicular peak hours. In some areas, pedestrian peak volumes may occur on the weekends.

The feasibility analysis should consider pedestrian delay due to additional travel time along an alternate route. Review the additional distance pedestrians have to cover as a part of the detour or diversion. In rare cases, with extreme pedestrian volumes, congestion induced pedestrian delays should also be considered.

E. Non-motorized Design Guidance

Non-motorized work zone design strategies are summarized below.

TABLE 5-1: NON-MOTORIZED WORK ZONE GUIDANCE: FACILITIES

• Pedestrians should be physically separated from the work zone and vehicles through the use of barriers and longitudinal channelizing devices.
• Pedestrian routes should be maintained free of any obstructions and hazards such as holes, debris, mud, construction equipment, stored materials, etc.
• Temporary lighting is not required, but should be considered for temporary walkways if the existing route is lighted.
• Hazards (ditches, trenches, excavations, etc.) near or adjacent to walkways must be clearly delineated and protected with appropriate channelizing devices.
• A covered pedestrian walkway may be required under, or adjacent to, elevated work activities including bridges and retaining walls.
• The minimum dimensions of a covered walkway for use by both pedestrians and bicycles should be 7 feet high by 4 feet wide, with a 32-38-inch handrail and a slip resistant walk surface.
• Where construction activities involve sidewalks on both sides of the street efforts should be made to stage the work so that both sidewalks are not out of service at the same time.
• Audible devices should be considered in urban areas where an existing device is provided, or in areas known to be frequented by individuals with visual impairments.
• Existing devices should be re-programmed or de-activated at locations where a facility is closed or detoured.
• Audible devices should be proposed at temporary or detoured crosswalks if existing devices were provided at the closed crossing.
• Coordination between the owner agencies of the existing audible devices is important to determine who will make the required modifications.
• Temporary pedestrian accommodations must be as accessible as the existing pedestrian facilities.

TABLE 5-2: NON-MOTORIZED WORK ZONE GUIDANCE: DETOURS

• Advance notice of closures to allow pedestrians to avoid the construction site entirely
• Detour routes should provide the most direct and safest route to minimize travel time and distance.
• A detour route, alternate pathway, or travel assistance is required to maintain pedestrian traffic if sidewalks on both sides of the roadway are closed.
• Signing should provide clear indications for each route where detours overlap.
• Provide advance signing at intersections rather than mid-block locations.

5.03 DETOURS

5.03.01 Pedestrian

Pedestrian detour routing or temporary pathways should be considered based upon the level of impact. To be effective, pedestrian detours need to be clear and concise. Using existing pathways, ramps, and crosswalks is preferred; however, it may be necessary to construct temporary facilities.

With a temporary pedestrian facility consider the following to determine if the proposed plan is appropriate:

- Number and demographics of pedestrians
- Environmental Clearance Requirements (Section 5.02.A) are satisfied
- Roadway ADT
- Crosswalk configuration
- When possible, avoid the use of non-signalized crosswalks.

Temporary facilities should be a minimum of 4 feet wide, however, 5 feet is desirable. If the temporary facility sidewalk is bi-directional and 4 feet wide, a 5 x 5 foot passing space is required for every 200 feet of length.

The temporary facility must be designed such that ADA compliant accessibility is provided, at minimum, to the same level as the existing facility. To the extent practical, it is recommended to design temporary facilities to full ADA standards. If additional guidance is required for complex location contact the WZDE for guidance.

Alternate pedestrian routes should be smooth and level. The use of a smooth, firm, stable, slip resistant, and continuous hard surface (compacted soils, aggregate and sand are not to be used) is required to provide an acceptable temporary pedestrian route. For more information about the temporary surface characteristics see the following:

- Special Provision for Temporary Pedestrian Passing Space
- Special Provision for Temporary Pedestrian Pathways

Physical barriers need to be provided to prevent pedestrians from entering the work area. Pedestrian channelizing devices or pedestrian barrier with fence may be used for increased protection.

If a covered pathway is used to protect pedestrians from overhead work, 5 foot-candles of illumination are recommended.

In the event of a full bridge closure, when a practical or alternate pedestrian route option does not exist, other mitigation measures should be considered. Such measures include the use of temporary structures and licensed transportation shuttles to transport pedestrians around the closure.

Where there is evidence of pedestrians but no pedestrian facilities (aka: a goat path), the route may be closed without a detour.

Pedestrians should not be temporarily rerouted across railroad tracks unless there is an existing pedestrian crossing. If unavoidable, contact MDOT's WZA.

Informational signs or other suitable devices should be used to provide reasonable notice to pedestrians, including the type and duration of construction activities. PCMS should only be used for pedestrian detours with substantial pedestrian traffic volumes.

For example, the placement of a PCMS for pedestrians at a stadium should clearly indicate that the message is for non-motorized traffic.

5.03.02 Bicycle (Future)

Intentionally Blank

5.03.03 Recreational (Future)

Intentionally Blank

5.04 SIGNING

The MMUTCD provides non-motorized sign details to help maintain consistent messages in work zones. The signs should be sized and positioned to provide clear, visible, and appropriate information.

Supplemental street name plaques should be added to the pedestrian detour signs for further clarity, especially when signing for multiple detour routes.

A minimum bottom height of 7 feet is typically required. If the sign and supports are clear of the accessible route and have no impact on non-motorized traffic, a minimum bottom height of 5 feet should be used. The sign and the sign support should be clear of the accessible route to eliminate tripping, vertical, and other hazards. See MMUTCD section 6F.03 Sign Placement for additional details.

Additional work zone signing for drivers should be considered in locations where pedestrian signs may conflict with vehicles signs (i.e. locations such as crosswalks and side streets).

5.04.01 Pedestrian

Positioning of temporary pedestrian signing should generally be just prior to potential route decision points. If a detour route is extended multiple blocks, is a complicated route, or other extenuating factors, confirmation signing should be incorporated along the route at potential decision points. An "*End Detour"* sign should be placed at the end of the detour to complete the process of directing pedestrians back to the original route.

If a business or business district with pedestrian access is cut off by a pedestrian detour, consideration should be made to include pedestrian specific signed route indicating that the businesses are open. Generic signs stating, *Businesses Open,* may be used. Specific names or advertisements may not be placed on signs.

5.04.02 Bicycle (Future)

Intentionally Blank

5.04.03 Recreational Vehicle (Future)

Intentionally Blank

5.04.04 CHANNELIZING DEVICES

Pedestrian channelizing devices should be used to delineate an alternate route. When used properly, they should indicate a suitable route for pedestrian travel around or through the work zone. The bottom and top faces of the pedestrian channelizing device should have retroreflective material or delineation for improved nighttime visibility. For more information about the characteristics, review the following:

- Temporary Pedestrian Type II Channelizer
- Temporary Pedestrian Type II Barricade

If a suitable alternate pedestrian route is not viable, it may be necessary to channelize pedestrians into the roadway. Utilizing continuous barriers is required for channelizing pedestrians into the

roadway where motor vehicle traffic normally travels. If pedestrian traffic is placed on the existing shoulder or in a location where there was no existing motor vehicle traffic, channelizing devices at a reduced spacing may be an acceptable method to provide separation.

Guidelines for effective pedestrian channelization are shown in Table 5-4. Additional information is provided in the US Department of Justice ADA Accessibility Guidelines, *American Traffic Safety Services Association* (ATSSA) guidance documents, and PROWAG

TABLE 5-3: CHANNELIZING DEVICE GUIDELINES

• Joints between segments should be closed and flush
• Bottom of the detection plate should be no more than 2 inches above the ground and extend to a minimum of 8 inches above the walkway.
• Must provide retroreflective delineation on traffic side of barrier
• Must meet crash protection, NCHRP 350 and/or AASHTO Manual for Assessing Safety Hardware (MASH) standards appropriate to the speed of traffic
• Must provide detectability for visually impaired pedestrians using a cane
• Guide rails are required. Top surface should be at least 32 inches above the ground and have a smooth continuous surface.
• Railings should be sturdy and fixed in place
• Avoid guiding pedestrians into the roadway
• Where pedestrians must be guided into the roadway, provide channelization including a positive barrier to protect them from vehicles intruding on the pedestrian path.
• Tape, rope, chains or similar devices are not allowed per the MMUTCD
• Vehicular and pedestrian signs should not obstruct the pedestrian route
• No protruding objects that could pose a trip hazard, obstruct or injure a pedestrian
• Existing pedestrian pathways may only be closed using Type II Pedestrian Barricades.

5.04.05 Pedestrian Barriers

Temporary barriers are devices designed to prevent or reduce work zone intrusion by vehicles, minimizing injuries to vehicle occupants. They are designed to provide positive separation of pedestrians from motorists and the work area.

When pedestrian traffic is placed in a location that motorized traffic normally travels, positive protection, facilitated by temporary barriers, is required when separating pedestrian traffic from motorized traffic on a temporary or permanent facility.
Types of temporary barrier protection used in construction work zones include items that meet the NCHRP Report 350 and MASH crash testing requirements:

- Concrete barriers
- Movable barriers
- Prefabricated steel barriers
- Water filled barrier wall (avoid use if construction extends into winter)
- Barrier with attached fence

Barriers can be one of the most effective safety measures used in a work zone to separate pedestrians from the work area and traffic.

When there is concern that pedestrians may climb over a barrier, consider installing a temporary pedestrian barrier with fence, consisting of a typical barrier section (usually concrete, or water-filled) and a six-foot tall chain link fence attached to the top of the barrier wall.

This type of device greatly discourages pedestrians from proceeding into the construction area or into live traffic. Pedestrian barrier walls with fence are crashworthy and ADA compliant. For more information see the Special Provision for Temporary Pedestrian Barrier with Fence. The following elements should be considered for the use of barrier walls:

5-4: BARRIER USE CONSIDERATIONS

Excavations
Drop offs
Unprotected features (walls, piers, sign structures, foundations, etc.)
Working and non-working equipment
Interim unprotected items (i.e. non-standard slopes, stockpiles, ditches within the roadway clear zone, etc.)
Number & nature of pedestrians
Proximity to and severity of hazards
Time of exposure
Barrier deflection distance
Vertical / horizontal roadway alignment
Hazard presented by barrier itself once in place
Hazard presented to pedestrians and traffic during barrier placement

5.05 PATHWAYS, CROSSWALKS AND RAMPS

It is preferable to use existing pathways, crosswalks, and ramps. Crosswalks and ramps should be located to allow pedestrians to cross during construction activities. More information about temporary ramps can be found in the Special Provision for Temporary Pedestrian Ramp.

Crosswalks that are temporarily closed, should be removed or blocked. The use of temporary surfaces is acceptable for temporary pathways and should be ADA compliant or at a minimum provide an equivalent existing level of accessibility. Design, construction, and maintenance guidelines for pathways, crosswalks and ramps are provided in the following tables:

TABLE 5-5: PATHWAYS, CROSSWALKS AND RAMPS GUIDELINES: DESIGN

• Pathways should be clear and flat.
• Detectible warning surfaces should be used at the ends of crosswalks on ramps.
• The pathway grade should not exceed 5% without incorporation of level landings.
• Temporary level turning spaces should be provided at ramps (minimum 4x4 feet, preferred 5x5 feet.)
• Cross slope perpendicular to traffic should be no more than 2%.
• Pathways must be at least 4 feet wide with 5 feet width preferred.
• Passing spaces must be provided at 200 feet intervals if the pathway is less than 5 feet wide.
• Passing spaces must be at least 5x5 feet.
• The maximum allowable rate of change of grade is 12.5%. The rate of change is determined by measuring the grade difference and the distance over which it occurs.
• A level turning space is required at both ends of a temporary curb ramp.

TABLE 5-6: PATHWAYS, CROSSWALKS AND RAMPS GUIDELINES: CONSTRUCTION

• Joints should be closed and flush.
• Vertical discontinuities along pedestrian routes should be less than ¼ inch.
• All surfaces should be firm and slip resistant.

TABLE 5-7: PATHWAYS, CROSSWALKS AND RAMPS GUIDELINES: MAINTENANCE

• Clear pedestrian facility of debris, trash, mud, snow, ice, and standing water.
• It is preferable that drainage runs perpendicular to the pathway

5.06 TRAFFIC SIGNALS

In most cases, temporary traffic signals for pedestrians will not be required but may be warranted where high volumes of pedestrians are expected. A review of the pedestrian and/or school crossing warrants in the MMUTCD Part 4 is recommended.

The pedestrian signal heads should be reviewed and adjusted if the crosswalk is being modified to meet MMUTCD requirements for visibility. Pedestrian push button locations adjacent to level landing areas should be reviewed and updated to meet current standards. Locations of signalized temporary crosswalks with pushbuttons should be initially designed to work in all stages of construction. It may be necessary to move the pushbuttons with each stage if the initial crosswalk location is moved.

Adjustments for push button height should consider changes in the elevation of the level landing as temporary surfacing and final walkway surfacing is placed.

If the crosswalks or ramps are modified, the signal timing permits should be reviewed and updated. The pedestrian clearance intervals should be updated based on:

- Crosswalk length
- Level Landing location
- Pushbutton location
- Changes expected in pedestrian volumes

Temporary or permanent pedestrian traffic signals and pushbutton signs should be bagged when a crosswalk is closed. The corresponding pushbutton to the bagged pedestrian traffic signal should be deactivated and the locator tone turned off.

Temporary audible devices should be considered on a case-by- case basis for existing audible devices at crosswalks and where the proposed operation may be confusing to a person with a visual disability. The MDOT Pedestrian Signal Guidelines should be reviewed to determine the need for audible pedestrian signals at existing signalized intersections within the work zone.

5.07 TRANSIT STOPS

Access to existing transit stops should be maintained to retain access and associated pathways should follow standards similar to other temporary pathways. Consult the local transit agency regarding the proposed work zone and impacts to pedestrians and transit operations.

Temporary stops should be provided when existing transit stops cannot be maintained. They should include a level landing for waiting passengers and a hard-surfaced path to connect to the adjacent pedestrian facilities. Signing should be updated to direct riders to the new stop.

Accommodations for transit passengers with disabilities are to be considered. Transit vehicles typically have ramps or other ADA compliant methods to allow wheelchair access to transit vehicles. The design of temporary transit stops should accommodate these riders and the transit system vehicles. For more information see Special Provision for Temporary Bus Stop.

When a transit stop cannot be maintained, closure may be considered with agreement from the transit agency.

5.08 GRADE SEPARATED CROSSINGS

In most cases, pedestrians will cross roadways via crosswalks. In rare cases, it may be unsafe or the pedestrian volumes are high that a grade separated crossing is necessary.

If a grade separated crossing is required, it should be constructed to meet the current level of accessibility of the existing pedestrian facilities. Contact the WZA for additional details.

5.09 NON-TRADITIONAL FEATURES

Temporary islands, speed bumps and other non-traditional pedestrian traffic control devices are not typically necessary for temporary situations. If you are considering the use of one of these devices contact MDOT's WZA.

5.10 LIGHTING

Adequate lighting is important to pedestrians as it provides a sense of personal security, safety, and enables signs and instructions to be seen clearly. Many visually impaired pedestrians testify to the importance of good lighting conditions. When planning a pedestrian pathway as part of a TCP, consideration should be given to avoiding trees and other objects that would cast a shadow and obstruct the light output.

Temporary lighting should be considered for temporary covered pathways or in areas where the lack of additional lighting may present a safety concern. Balloon Lighting or a form of diffused lighting should be utilized.

CHAPTER 6

TRAFFIC CONTROL DEVICES AND IMPLEMENTATION

6.01 TEMPORARY TRAFFIC CONTROL

Temporary traffic control devices used in work zones are required by FHWA to meet the requirements of Part 6 of the MMUTCD.

Federal regulations also require all roadside devices, such as portable sign stands, barricades, barrier terminals, crash cushions and other work zone hardware to be compliant with NCHRP 350 and / or MASH crash test requirements.

Devices used on MDOT facilities must also follow the requirements detailed in MDOT's Standard Specifications for Construction, and other policy related documents.

Sometimes it is necessary to decrease spacing in between channelizing devices to keep vehicular traffic out of the work zone. It is not acceptable to use caution tape to tie channelizing devices together in the roadway.

6.01.01 Cones

Cones used on freeways and other high-speed highways must be a minimum of 28 inches tall. The exception to this rule allows 18-inch cones to be permitted for the protection of uncured pavement markings where no static lane closures are used.

Cones smaller than 42 inches in height are prohibited for use at night on all MDOT roadways.

6.01.02 Plastic Drums

Drums must be provided as detailed in WZD-125 and meet the requirements detailed in section 812 and 922 of the MDOT Standard Specifications for Construction.

The spacing between plastic drums on roadways must follow the guidelines outlined below in Table 6-1 Channelizing Device Maximum Spacing.

EXHIBIT 6-1:
FLORESCENT DRUM

TABLE 6-1:
CHANNELIZING DEVICE MAXIMUM SPACING

Work Zone Speed Limit	Taper	Tangent
< 45 mph	S	2 x S
≥ 45 mph	50 feet	100 feet

S=Work Zone Speed Limit (mph)

6.01.03 42 Inch Channelizing Devices

42-inch channelizing devices (grabber cones) are recommended when a plastic drum restricts the proposed lane widths to less than 11 feet, including shy distance.

EXHIBIT 6-2:
42 INCH CHANNELIZING DEVICE

Grabber cones are recommended for Capital Preventive Maintenance (CPM) projects such as chip seal, micro-surface, concrete repairs, and crack seal applications, or any daytime closure lasting less than 12 hours.

They are also recommended for use when lane closures are required to install pavement markings on freeways.

If cones are specified in the contract, use of 42-inch channelizing devices may be permitted at the expense of the contractor. Lights on 42-inch channelizing devices are not allowed.

When 42-inch channelizing devices are used during nighttime work the devices spacing is a maximum distance of 50 feet apart in tangent sections, and a maximum of 25 feet apart in tapers. These spacing requirements apply for all speed limits.

Grabber cones weigh less than plastic drums and require ballast for different conditions. 30 lb. ballasts are recommended for freeways and 15 lb. ballasts are recommended for non-freeways.

6.01.04 **Tubular Markers** (updated 1/20/2020)

Use of tubular markers should only be considered after other channelizing devices have been ruled out. Tubular markers are not a recommended channelizing device unless used to separate traffic or work operations. They may be used in work zones where more permanent delineation (attached to the pavement) may be required during winter shutdown.

EXHIBIT 6-3: TUBULAR MARKERS

Tubular markers are required to be a minimum of 28 inches in height. Markers less than 42 inches should have two three inch white reflectorized bands placed at the top, and markers 42 inches or greater should have four 4- to 6- inch wide alternating orange and white stripes with the top stipe being orange.

6.01.05 Delineators

Delineator panels are not allowed for channelizing but may be used for roadside safety delineation based on engineering judgment.

Flexible delineators, delineator panels, and flexible guardrail delineators are used along narrow shoulders, next to an open ditch section on 3R and 4R freeway projects as described in WZD-126-A. Flexible delineators and delineator panels should be located one foot off the edge of the paved shoulder and spaced at a maximum distance of 200 feet, unless otherwise directed by the Engineer.

Other types of delineation devices include; concrete barrier reflectors, guardrail reflectors, and lateral clearance markers and must be included in the TTCP.

EXHIBIT 6-4:
FLEXIBLE DELINEATOR

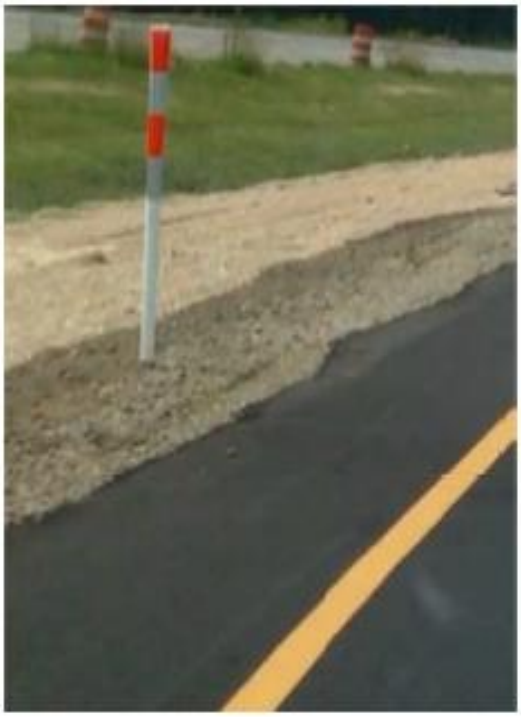


EXHIBIT 6-5:
DELINEATOR PANEL

EXHIBIT 6-6:
FLEXIBLE GUARDRAIL DELINEATORS

6.01.06 Barricades

Barricades are used to control traffic by closing, restricting or delineating all or a portion of a roadway.

EXHIBIT 6-7:
TYPE III BARRICADE

Only Type III barricades are allowed for use with motorized traffic on MDOT projects.

Barricades are equipped with reflective sheeting that is intended to be a directional indicator. Stripes angled down to the right indicate passing on the right, whereas angled down to the left indicates passing on the left. Stripes angled down to the middle of the barricade indicate a closure. Stripes angled upward to the center of the barricade indicate passing on both sides.

Type III barricades are required to have two working type C lights attached, as detailed in WZD-125 and MDOT's Standard Specification for Construction.

6.01.07 Temporary Barriers (updated 1/20/2020)

Barriers are devices designed to prevent or reduce work zone penetration by vehicles while minimizing injuries to vehicle occupants. They are designed to provide positive separation of motorists from workers, bicyclists, and pedestrians. Types of barrier protection include concrete barriers, movable barriers, prefabricated steel barriers, and water filled barrier walls.

A temporary barrier wall should be installed on a compacted aggregate or paved surface. This surface must be flush with the surface adjacent to the barrier. If a limited deflection barrier is used it must be on a surface as detailed in Standard Plan R-53.

Barriers are required to meet quality standards contained in the current edition of the American Traffic Safety Services Association (ATSSA) Quality Guidelines for Temporary Traffic Control. Temporary traffic barriers are required to meet NCHRP 350 and / or MASH crash testing criteria, meeting a minimum of Test Level 3.

Barrier endings must be located outside of the clear zone or fitted with an impact attenuator, as detailed in Standard Plan R126. Additional information on temporary barriers is available in Section 7.01.67 and 7.01.68 of the Roadway Design Manual. See table 6-9 Edge Drop-off Treatments for detailed barrier wall use information.

Consideration should be given to extend the barrier wall past the work area, both upstream and/or downstream to encompassed materials, equipment and work operations. Worker access to the job site should also be protected when practical. The length of need should be shown or detailed in the internal traffic control plan. Each location should be evaluated to determine the length of need, as a best

practice a range of 100 to 300 feet is recommended.

The following tables include elements to consider when deciding on the use of barriers and examples of typical barrier applications.

TABLE 6-2:
BARRIER USE CONSIDERATIONS

Excavations
Drop offs greater than or equal to 12 inches, that will not be backfilled overnight
Unprotected features (walls, piers, sign structures, foundations, etc.)
Working and non-working equipment
Interim unprotected items (i.e. non-standard slopes, stockpiles, ditches within the roadway clear zone, etc.)
Proximity to and severity of hazards
Duration of exposure
Size of work area available
Traffic exposure to opposing traffic
Contractor mobility and ingress / egress
Volume of traffic
Work zone speed
Barrier deflection distance
Vertical / horizontal roadway alignment
Hazard presented by barrier itself once it is in place
Hazard presented to pedestrians and traffic during barrier placement

TABLE 6-3: BARRIER USE TYPICAL APPLICATIONS

• To keep vehicular traffic from entering work areas, such as excavations or material storage sites.
• To separate workers, bicyclists, and pedestrians from motor vehicle traffic. See Chapter 5 for more information.
• To separate opposing directions of freeway traffic.
• Where drums or cones do not provide adequate guidance for the motorist or for the protection of the worker.
• Where workers are exposed to unusually hazardous traffic conditions.
• Where existing traffic barriers and bridge railings are removed during a construction stage.
• On all bridge work where a precipitous drop-off is within 4 feet of the toe of the barrier closest to the active traffic lane. Examples of precipitous drop-offs include but are not limited to: o Bridge deck work with open holes in the deck. o Bridge railing removed
• On projects where scaffolding or other structures or equipment with workers overhead are in place for three days or more.

The following alternatives to using temporary barriers should be considered due to risks to drivers and workers during placement and removal of the devices:

- Buffer lane closures
- Nightly backfill of excavations
- Tapers
- Temporary detours or crossovers
- Additional or closer spacing of channelizing devices and extra warning signs

Barriers must be used on freeway projects where opposing traffic lanes are shifted and are adjacent to each other.

A. Movable Barriers

Moveable barrier walls are designed to move laterally as a unit to close or open a traffic lane. Adequate storage sites at both ends of the barrier are required for the barrier transfer machine. Movable barrier walls meet NCHRP 350 and MASH Test Level 3.

EXHIBIT 6-8:
MOVEABLE BARRIER OPERATION

B. Water Filled Barrier

Consideration for using this barrier should be limited to low speed, low volume roadways where an improvement over the use of traffic cones or drums is needed. Water filled barrier walls should not be used as a replacement for concrete barrier walls due to their large deflection.

C. Barrier Endings (attenuation)

Within the clear zone, the approach ends of temporary barriers, are fitted with impact attenuators to reduce the potential for occupant injury during a vehicle collision with the barrier. Details for placement of impact attenuators on approach ends of the barriers may be found in the Standard Plan R-126. WZD-175 covers one layout of sand module impact attenuators.

If work extends into a time frame in which the weather could drop below freezing, the manufactures recommendation for anti-freeze treatments must be followed when using a water filled attenuator system.

D. Mobile Attenuators

Truck mounted attenuators (TMA) and trailer mounted attenuators are referred to as mobile attenuation as described in the Frequently Used Special Provision 12SP812(A). Mobile attenuators are recommended to protect personnel or equipment when one or more of the following conditions exists:

TABLE 6-4:
MOBILE ATTENUATORS RECOMMENDED USE

Aerial work is performed on scaffolding, lifts, hoists, bucket trucks, etc., when workers using this equipment are in a closed lane not protected by temporary barrier. *(Not intended to be used for the removal, installation, or maintenance of traffic signals.)*
Aerial work is performed on scaffolding, lifts, hoists, bucket trucks, etc., where workers using this equipment are on the shoulder and not protected by a temporary barrier for longer than one hour. *(Not intended to be used for the removal, installation, or maintenance of traffic signals.)*

Mobile attenuators must not be mounted on the vehicle or equipment used by personnel to complete aerial work. The use of a mobile attenuator should be considered for other operations depending upon the level of worker exposure. Engineering judgment should be used to determine the appropriate form of TTCD to complete the work on every project.

Mobile attenuators may not be used as a barrier ending except during the replacement of a damaged barrier ending. When a mobile attenuator is used as a temporary safety measure for a damaged barrier ending; it may only be used for a maximum of 48 hours or as approved by the Engineer.

For more detailed information and guidelines on the placement of mobile attenuators, reference the Maintenance Work Zone Traffic Control Guidelines.

6.01.08 Temporary Signs (updated 1/20/2020)

Work Zone signing can range from ground driven wood supports to portable temporary roll-up signs. The size of the sign and the duration and location of the work will determine which type of sign should be used. All temporary signs must be crash tested to meet the requirements of *National Cooperative Highway Research Program Report 350 (NCHRP 350)* or *Manual for Assessing Safety Hardware* (MASH). The size of sizes must follow table 6F-1 Temporary Traffic Control Zone Sign and Plaque Size of the MMUTCD.

While it is not required for all projects, it is recommended to show the specific temporary sign locations on the plans or location detailed in the special provision for maintaining traffic. This effort during design will assist in providing more accuracy in the field to ensure proper placement and reduce the number of obstructions and conflicts.

A supplemental plaque is recommended when signs are located on a side street leading into where the work is taking place. A 2 x 2 foot route marker or the road name should be used and can be spelled out if space allows as shown in Exhibit 6-9.

EXHIBIT 6-9: ROAD NAME PLAQUE

A. Ground-Driven Temporary Signing

Ground-driven temporary signing mounted on conventional driven sign supports should be used for projects that last more than fourteen days. Portable sign supports should be used when it is not possible to use ground-driven sign supports.

Cover or remove existing signs that can be misinterpreted or that may not apply

during construction. Signing must be reviewed throughout the life of the project to ensure messages are current and meet the needs of the motorist.

B. Portable Temporary Signing

Portable temporary signing is generally used in short term and mobile work zone operations where frequent repositioning of the signing is necessary to keep pace with the work along the roadway. Portable temporary signs must be mounted on crashworthy sign supports at a 5 foot bottom height, including signs located in the closed section of a walkway. If erecting signs behind a curb, or within 6 feet of a pedestrian walkway, mount signs at a bottom height of at least 7 feet above ground.

Portable sign systems should not be left up unless active work is taking place. When signs are removed they must be stored in accordance with *section 812.03.D.1 of the Standard Specifications for Construction.*

Portable sign supports should only be used with the recommended ballast for wind conditions approved by the manufacturer. If signs cannot withstand wind conditions in the field, they should be ground-driven or work postponed until conditions allow work to take place safely.

When a Leap Frog traffic control method is used, it requires additional sets of signs to increase productivity and mobility, project offices should pay for two additional sets of temporary signing. The operation places signs in the correct location and has them stored on the ground and then stands the signs up in the new location and lays the signs down as the operation progresses down the road. The additional sets of signing will keep the operation moving, thus lessening the number of days needed to complete the work.

C. Portable Temporary Signing – Roll-up

Signs made of roll up material must not be used at night or during hours of darkness. This includes early mornings before the sun rises.

D. Innovative Temporary Signing (Added 1/20/2020)

In areas with limited space or specific geometric features traditional temporary sign may not function ideally so the use of an innovative signs should be evaluated.

1. Concrete Barrier-Mounted Temporary Sign System

In locations with concrete barrier wall and limited space the Barrier mounted sign should be considered. The condition of the existing barrier wall should be evaluated during the design phase to verify the condition. In areas with limited shoulder width the size of the sings can be reduced as detailed in table 6F-1 Temporary Traffic Control Zone Sign and Plaque Size of the MMUTCD. For more details on this device see the previously approved special provision Concrete Barrier-Mounted Temporary Sign System-12DS812(I160)Rev1.doc

2. Temporary Water Filled Base Sign System

In locations that don't allow for temporary signs to be post driven an alternative to consider is a water filled base sign system. This sign system provides a sturdy base without the need to drive into the ground. Ideal locations are bridge decks or paved shoulders.

This sign system can also be utilized in lieu of type III barricades in locations where there is a high potential for devices to be moved by the motoring public. The

next weight of the system is above 400 lbs when filled with water. For more detailed information see the recommended special provision Temporary Water Filled Base Sign System-12RC812-A445-01-06-25-15.pdf

6.01.09 Sign Covers

Temporary sign covers must cover the entire legend or symbol when the sign is less than 60 square feet. The material used needs to be opaque during all light and weather conditions. Lifting devices cannot remain attached to the sign covers. When sign covers are removed, they must be laid flat on the ground. *See section 812.03.D.2 Sign Covers of the Standard Specifications for Construction* for additional details.

When covering overhead signs or signs larger than 60 square feet, the contractor is not required to cover the entire sign but must ensure conflicting information is covered, using a Type 1 sign cover. Placing a closed sign across an exit sign as shown in exhibit 6-10 provides the motorist with the best information and allows them to understand which exit is closed.

EXHIBIT 6-10: SIGN COVERS

For additional information *see section 812.03.D.2 and 922.02.D of the Standard Specifications for Construction*.

6.01.10 Covering Signs

Existing signs must be covered or removed and replaced with the appropriate temporary regulatory signing. Sign covers not in use must be stored in accordance with 6.01.11. Additional information is provided in the MMUTCD Part 6 (Section 6F.07).

A. Directional Guide Signs

< 24 hours
When a detour is to be placed for 24 hours or less, all existing conflicting permanent signs should be covered as determined by the Engineer.

> 24 hours
When a detour is to be placed for more than one day, all existing conflicting permanent signs must be covered.

B. Overhead Signs

The covering of overhead signs is always recommended but may not always be practical. For this reason, the requirements will be determined at the project level and detailed in the plans. The message and length of the project should be used when determining what signs will be covered or modified. Projects lasting longer than 14 days should have overhead signs covered.

C. Regulatory Signs

Regulatory signs, such as speed limits, with contradictory information must be covered.

6.01.11 Signing Coordination

When projects have traffic control that overlaps with another project, a coordination clause should be developed for all projects that are affected. If multiple projects are going to be in the same location, a removable marking or tag may be considered for tracking and payment purposes. Requiring project numbers or permanent identifiers must not be used.

6.01.12 Project Specific Signing

Unique and special temporary signs must be detailed (i.e. SignCAD) and included in the contract documents. Special temporary sign locations should be specified in the TTCP and the special provision for maintaining traffic.

When designing project specific signing, motorist comprehension of the sign and the meaning needs to be considered. If the information on the sign cannot be quickly processed by a passing motorist who is not familiar with the area, multiple signs may need to be utilized. It is recommended to have a person not familiar with the project review the design to determine if the sign is easily understood.

6.01.13 Temporary Pavement Markings

Temporary pavement markings are installed in work zones to provide road users with a clearly defined path for travel through the work zone.

The two types of temporary pavement markings designated in the pay items, include Removable “Type R" and Non-Removable “Type NR".

Temporary wet reflective pavement markings increase guidance through the work zone during dry and wet conditions Temporary wet reflective pavement markings may be paint or preformed tape and must be selected based on the pavement surface and time of year they are placed. Temporary Type R Tape and Type NR Paint pavement markings must be wet retroreflective.

For additional details please see Frequently Used Special Provision

(FUSP) 812V Temporary Pavement Marking Revisions.

Temporary markings must be removable if applied to the pavement surface course, unless lines are painted in the final configuration and the final marking is not a durable marking. Type R tape should not be used on courses other than the surface course unless the marking is removed prior to paving.

Type NR Tape pavement markings may be used to mark the base and leveling courses of asphalt and need not be removed. Type NR Tape is not to be used on any final surface course.

Payment for removing pavement markings, when necessary, will only be made for Type NR markings.

Temporary pavement marking products approved for use are listed on MDOT's Qualified Product List.

A. Pavement Marking Removal

Non-applicable or inappropriate permanent pavement markings must be removed before making any changes in the traffic pattern that will last longer than three days. This may be done using grinding, air or water blasting. Painting over existing markings is not allowed per section 812.03.F Standard Specifications for Construction.

Scarring caused by the removal of temporary markings can result in a permanent shadow of a line that may be followed by a motorist. Temporary markings must be designed and placed such that abrasive removal techniques that result in the scarring are not used. To prevent scarring that could confuse a road user out of their lane, temporary wet reflective removable tape should be used in shift / taper sections.

B. Shift Markings

All temporary traffic shifts (except merging tapers) on freeways should be striped with 8-inch solid Wet Reflective Type R, Tape. 8-inch solid edge and lane lines must be placed 300 feet prior to the traffic shift, through the shift, and 300 feet after the traffic shift. This is required for both entry and exit shifts.

To provide contrast on concrete surfaces, a 4-inch white line may be used next to a 4-inch black contrast line. A field review should be conducted prior to choosing this method to ensure the black contrast tape does not conflict with existing crack seal.

Non-freeway shifts (except merging tapers), must be striped with 4-inch solid Wet Reflective Type R, Tape edge lines and lane lines must be placed 150 feet prior to the traffic shift, through the shift, and 150 feet after the traffic shift. This is required for both entry and exit shifts.

The leading and trailing markings described above are used to provide motorists with additional guidance and reassure the driver they are in the correct location, as the lane lines will have just been modified.

C. Temporary Raised Pavement Markers (TRPM), Type 3

TRPM, Type 3, may also be used to supplement edge line markings in temporary crossovers and traffic shifts. Spacing of devices should be at a minimum of 25-foot intervals beginning 250 feet in advance of the cross over shift and ending 250 feet beyond the crossover point on the tangent section.

D. Pavement Marking Cover

Covering existing markings with black Type R tape is allowed when specified in contract documents or as directed by the Engineer. Covering existing markings is

typically done on short term tapers or in areas with frequent lane closure changes and must be done with black tape.

E. Curing Compound Removal

On newly paved concrete surfaces, the cuing compound should be removed prior to placing temporary markings. Removal of curing compound prior to placing temporary markings on new concrete must be done by water blasting. This will minimize the scarring of the surface. If the final markings are going to be placed in the same location, water blasting is not required.

F. Edge Line Markings

Temporary edge lines should be placed on new pavements in place for longer than three days or drums placed at 200 foot spacing or 42 inch channelizing devices placed at 100 foot spacing may be used to delineate the shoulder. Edge line markings are recommended for placement after 14 days. If temporary edge line markings are not placed after 14 days, the reasons should be documented.

Broken line applications of temporary paint or tape are not acceptable for edge line delineation. If the project requires striping in stages, it should be striped with temporary wet reflective markings until landscaping is complete, excluding water and cultivating.

G. Capital Preventive Maintenance (CPM) Projects

For CPM Micro-Surfacing projects, temporary pavement markings application and guidelines should be as described in Frequently Used Special Provision 12SP811(E).

For chip seal, micro surface, and crush and shape projects, place Temporary Raised Pavement Markers (TRPM) – Type 1, in accordance with the manufacturer's specifications to mark the centerline of the roadway. Space TRPMs at 25 feet (6F.79 of the MMUTCD).

6.01.14 Lighting (updated 1/20/2020)

Lighting is required for night work in accordance with the Frequently Used Special Provision (FUSP) 12SP812CC-01 and FUSP 12SP812DD-01. When traffic regulators are necessary for nighttime construction activities, supplemental lighting of the traffic regulators stations with balloon lighting is required.

EXHIBIT 6-11
BALLOON LIGHTING

Consideration should be given to placement of the lighting to ensure it does not shine into the drivers' eyes.

Provide a minimum illumination intensity of 10-foot candles (108 lux) on a jobsite where construction work is performed. Maintain a minimum of 5-foot candles (54 lux) throughout the entire area of operation where workers pass on foot or are present but are not performing construction work.

Lighting levels will be measured with an approved light meter (cell phone applications are unacceptable). Readings will be taken where the work is performed, in a horizontal plane, 3 feet

above the pavement or ground surface. Vehicle or equipment headlights are not an approved light source.

6.01.15 Portable Changeable Message Sign (PCMS)

PCMS are an effective way to provide additional information to road users. Usage must be designed according to the needs of the project and follow the PCMS Guidelines in Appendix F.

PCMS may be programmed with specific messages which may be modified as needed and are supplemental to other warning signs. Only two message screens per PCMS are allowed. If additional information is necessary, an additional PCMS should be used at a separate location.

TABLE 6-5: PCMS TYPICAL APPLICATIONS

• Long queuing and delays are expected
• Adverse environmental conditions are present (i.e. ice, snow, wind)
• Major changes in alignment or surface conditions
• Where advance notice of ramp, lane or roadway closures is necessary, due to a desire to increase traffic diversion
• Advise of a crash or incident
• Changes in the road user pattern
• Work zone stage changes
• Road work scheduling advisories
• Real-time travel time messages

Designers should limit the usage of PCMS boards to specific areas and include specific language in the TTCP for each board at each stage. PCMS boards should not be used in the same location displaying the same message for more than 2 weeks. Static temporary signs should be considered for such locations. The National Transportation Communications for ITS Protocol (NTCIP) compliant PCMS aids in posting traffic incident response messages, current and accurate construction scheduling messages, or real-time traveler information.

The NTCIP system should be considered on all projects. It is recommended to use NTCIP compliant PCMS for projects that do not have a dynamic message sign in place, areas containing historically high crash rates, remote areas or high impact roadways. Use should be considered and documented during the development of the project. If a project warrants the use of travel time messages that require more than eight characters per line, or a message with formatting that does not fit on a standard PCMS, then the use of the Full-Matrix NTCIP-Compliant PCMS is needed. Region approval is required prior to the use of a full matrix PCMS.

6.01.16 Temporary Traffic Signals

Temporary signals are typically used in work zones to control traffic when one lane is closed and alternating traffic movements are necessary. For temporary traffic signal installations, provide a TTCP that includes the location in relation to the work operation, based on the geometrics, operation and delay of traffic.

When work operations are suspended and traffic lanes will be open for less than 72 hours, the temporary signal may remain in place in flash mode. If the temporary signal will be non-functional for longer than 72 hours, the signals should be removed from the roadway. When signals are removed, signs must be removed or covered.

A. Temporary Mounted Signal System

A fixed temporary signal system is recommended where there is adequate power available and the temporary signal will be in place for 30 days or more.

Temporary traffic signals should have actuation when one or more of the following conditions exist on the project site:

- Traffic volumes are low enough to create time periods when a vehicle would be held on a normally timed red signal with no opposing traffic present.

- Traffic volumes are unbalanced and heavy directional traffic may be stopped on multiple red indications before the entire queue can clear the signal.

The temporary signal configuration must be evaluated to determine the recommended timing for each stage of construction. The temporary signal timing must be determined using the approved mobility analysis tools summarized in Section 3.03.

Typical intersection evaluations use Synchro software or the procedures outlined in the HCM to determine the temporary signal timing. MDOT's Traffic Signals Unit should be contacted for the temporary mounted signal timing and for any further questions.
For more information on temporary signals see section 3.01.03.

B. Temporary Portable Signal System

A Temporary Portable Signal System is recommended for locations when it is not feasible to use a temporary mounted signal system or where the signal will be in operation for less than 30 days. Signal timing for temporary signals are based on speed and the length of the work zone. Contact the WZA for timing assistance.

1. Temporary Portable Traffic Signal (PTS) System – Trailer Mounted

Each PTS system consists of two trailer-mounted, solar powered portable traffic signals with battery back-up.

A trailer mounted system is recommended when a temporary portable signal system is in place, without active work. This device carries a larger footprint than a pedestal mounted system but provides a more stabilized setup which is needed for longer durations.

Exhibit 6-12: Temporary Mounted Signal

2. Temporary Portable Pedestal-Mounted Traffic Signal System

A temporary portable pedestal mounted traffic signal system is defined as four connected pedestal-mounted traffic signal units designed to control two directions of traffic. This device has a smaller footprint, is more portable than a trailer mounted system, and does not place a signal head over the active lane (has a signal on each side of the roadway).

A Temporary portable pedestal mounted traffic signal system may only be used when active work is taking place. It should be considered for projects that will frequently change locations. This system may also be used in lieu of a traffic regulator operation when the project location has limited access points and does not require intermediate traffic regulators.

EXHIBIT 6-13
TEMPORARY PORTABLE PEDESTAL-MOUNTED TRAFFIC SIGNAL

6.01.17 Automated Flagger Assistance Device (AFAD)

An AFAD is a traffic regulator machine that is operated remotely by a traffic regulator located off the roadway and away from traffic. The device is a safety enhancement for projects that use alternating traffic control by physically placing the human traffic regulator off the roadway while maintaining control of the traffic movements approaching the work zone.

If a contractor elects to use an AFAD please contact the WZA to ensure the device used is acceptable for use on MDOT roadways.

6.01.18 Glare Screening (updated 1/20/2020)

Glare screening is used on temporary barriers separating opposing traffic to reduce headlight glare from oncoming traffic. This screening also reduces the potential for motorist confusion by shielding the headlights of other vehicles on adjacent roadways or construction equipment.

Glare screening should be used on all projects where opposing traffic is separated by temporary barrier in tangents, crossover locations, curved areas and elevation changes.

6.01.19 Transverse Temporary Rumble Strips

Transverse rumble strips are used to provide a tactile and audible alert to traffic, typically in advance of a closure/shift point. They alert motorists to changing roadway geometry, advance notification, or stop conditions. Noise consideration should be a factor when determining locations.

A. Fixed Temporary Transverse Rumble Strips – Freeway

Fixed transverse rumble strips may be placed on freeway projects that remain in place for three days or more as determined by the Engineer. They should be considered on freeway projects with sight distance concerns, where traffic volumes are such that queues extend well past the typical influence area or where changing conditions warrant additional driver attention.

Rumble strips may also be used to draw additional attention to temporary signing. Rumble strips should be located upstream of the sign (500 to 1,000 feet) to allow distracted drivers time to hear the sound, refocus on the roadway, and observe messaging that may be in place. This method is extremely effective when using a stopped traffic advisory system, detailed in section 6.06.04.

The Previously Approved Special Provision TEMPORARY RUMBLE STRIPS (ORANGE) IN ADVANCE OF A WORK ZONE should be utilized.

EXHIBIT 6-14: TEMPORARY RUMBLE STRIPS IN ADVANCE OF A WORK ZONE

B. Fixed Temporary Transverse Rumble Strips - Non- Freeway

When a project modifies or establishes a stop condition, the Previously Approved Special Provision TEMPORARY RUMBLE STRIPS (ORANGE) IN ADVANCE OF A STOP CONDITION should be utilized.

EXHIBIT 6-15: TEMPORARY RUMBLE STRIPS IN ADVANCE OF A STOP SIGN

C. Portable Temporary Transverse Rumble Strips - Non- Freeway

Temporary portable rumble strips may be used on roadways with a speed limit of 65 MPH or less and should be considered for projects with active work, traffic regulating, or limited sight distance to the work zone. When utilized the special provision for Temporary Portable Rumble Strips should be utilized.

These devices are designed to be placed and removed with the lane closures. If the closure is to remain in place for an extended duration they must be monitored and adjusted as detailed in the specification.

EXHIBIT 6-16: TEMPORARY PORTABLE RUMBLE STRIPS

6.01.20 Existing Longitudinal Rumble Strips

Existing longitudinal rumble strips may make drivers uncomfortable if traffic is shifted onto them. When traffic is shifted onto the shoulder and places the vehicle wheel track within 12 inches of the rumble strip, the rumble strips may be removed, filled, or left in place. This treatment will vary depending on project duration, location, surrounding land usage and work type, as determined by the Engineer. Contact Pavement Operations for best practice information.

In transition areas where traffic is only shifted across the rumble strip, additional signing may be placed advising the motorist of the crossing.

In tangent areas where rumble strips will not be removed or filled, signing must be installed to advise motorists

EXHIBIT 6-17: RUMBLE STRIPS WARNING SIGN

6.01.21 Pilot Vehicles

Pilot vehicles are used in traffic regulator applications for one lane operations on two lane, two-way roadways. Pilot vehicles should be considered for any project in which diverted traffic may have difficulty navigating the temporary route or to control the pace of traffic such as crush and shape projects.

When determining the use of pilot vehicles, site conditions should be reviewed to ensure speeds are established appropriately.

Temporary traffic control is required when using a pilot vehicle. For further requirements of pilot vehicles, refer to MMUTCD Part 6 (Section 6C.13).

6.01.22 Innovative Traffic Control Devices

Traffic control devices not presented in this manual should be considered for use in work zones to reduce crashes, risks, and consequences of motorized traffic intrusion into the work space or to improve mobility. Please contact the WZA for information on recently developed/approved products, or to recommend a new product for a pilot project that may have a tangible benefit.

6.01.23 Rolling Roadblocks (Added 1/20/2020)

A rolling roadblock is a technique used to temporarily slow or stop vehicles in order to provide a gap in traffic in advance of construction activities. Temporarily removing or slowing traffic enables the completion of short-term work where a long-term closure using standard TTC devices is not needed.

A. Work Activities

Location and traffic volumes may require the contractor to perform a rolling roadblock to allow for access of construction vehicles and material delivery. This method should be used during off-peak hours and only when traffic volumes don't allow for ingress and egress into the work site and should be detailed as part of the internal traffic control plan.

B. Construction

Traffic should not be stopped for over fifteen minutes. Additional stoppages should not be conducted until the traffic queue has cleared completely. Traffic queue formations and dispersals should be monitored.

All efforts should be made to conduct all traffic stoppages utilizing law enforcement officials and vehicles. When not available, one construction vehicle per open lane of traffic with a permanently affixed rotating beacon or strobe light should be used. These vehicles should start in their appropriate lanes, beacons on, well in advance of the signing sequence flowing normally with traffic. As they progress through the signing sequence, they should slowly reduce their speed until a full stop is attained at the prescribed stopping point.

Appropriately marked construction vehicles with an amber rotating beacon and conspicuity tape should be used at a minimum. As a best practice a "Pilot Car, Follow Me" sign should be considered. Law enforcement should always be considered the first choice over contractor vehicles if this is to occur at a high frequency during the project.

C. Operations Plan

Before implementing a rolling roadblock for planned work, a meeting with all stakeholders to define responsibilities and ensure the activities for successfully executing a rolling roadblock should be

completed. An emergency plan should be developed to handle traffic should unforeseen circumstances occur. Emergency response agencies should be notified of the dates and times of the rolling roadblock. All efforts should be made to inform the public at least 3 days in advance of the roadblock. Dynamic message signs (DMS) or portable changeable message signs (PCMS) should be used to alert the users of the operation and when it will be happening that day including the day and hours. A press release should be issued to radio/television stations, newspapers, the agency's website, and any applicable agency social media sites. A final meeting among stakeholders before executing the rolling roadblock should be held to ensure all comments have been addressed.

6.02 SPEED LIMITS IN WORK ZONES (updated 1/20/2020)

Work zone speed management must follow current department policies, provided in *Guidelines to Establish Speed Limits in Work Zones*, located in Appendix E. Work zone speed limits should be monitored during construction.

Revisions or refinements should be considered if speed compliance by the road user is determined to be lower or higher than acceptable or if there are indications that the posted speed limits may be contributing to safety issues.

A temporary Traffic Control Order (TCO) is required when a speed reduction is posted when the work is 2 feet or greater from the edge of the traveled way and no lanes are closed. See the Traffic Regulations Guidelines and the Traffic Regulations Engineer Manual for more information about obtaining a traffic control order.

If the work is located within 2 feet of the traveled lane, a temporary TCO is required for speed reductions greater than 10 mph and reductions lowering the speed limit below 30 MPH, excluding the posting of 45 mph Where Workers Present (WWP).

For roadways with posted speeds of 75 mph, the speed should be reduced as follows, 75 mph to 70 mph leading into the work zone, reduce then to 60 mph and, when appropriate, 45 mph WWP, following current work zone guidelines.

In areas where the workers are protected by barrier wall 45 mph WWP should not be posted.

When speed reductions are used, the factors used to determine the reduced speed must be included in TTCP and must be based on engineering judgment.

6.03 QUALITY GUIDELINES

The condition and maintenance of traffic control devices is critical as they serve as the first line of safety for the work zone and transportation customers.

The quality of temporary traffic control devices is referenced in the most current edition of the *Quality Guidelines for Work Zone Traffic Control Devices and Features published by ATSSA.* This document is available for MDOT staff through the WZA or for purchase directly from ATSSA. Additional information may be found at http://www.atssa.com/ (on-line store).
Additional maintenance and cleaning requirements are shown in Sections 812 and 922 of the Standard Specifications for Construction. Inspection methods and acceptance criteria are detailed in section *4.10 Temporary Traffic Control Certification and Acceptance Procedure* of the Materials Quality Assurance Procedures Manual.

6.04 DETOURS & ALTERNATE ROUTES

The project designer should ensure that sign placement will fit the locations

shown along the detour or alternate route and that signing will not conflict with existing signs, bridges, driveways, trees, landscaping, or pedestrian movements. Detours and alternate routes should be reviewed for upgrades to existing signing, pavement marking and traffic signals. Considerations must be given to the adequacy of shoulders, lane widths, turning radius for commercial vehicles (Auto-turn or turning template(s)), and structural condition of pavement. Timing may need to be adjusted on signals along the detour route.

Project designers must coordinate and document approval of detours and alternate routes with local transportation agencies and affected parties to avoid conflicts with local projects and transportation needs (email may serve as official documentation). In addition, a field review of the detour should take place to assess route conditions. Traffic volumes should also be observed. Anticipated modifications to existing traffic patterns should be noted during the field review.

All existing restrictions (horizontal, vertical, weight) must be evaluated on the proposed detour or alternate routes to ensure that traffic is not further impeded or restricted. Emergency services should be provided access to the worksite at all times for any emergency related event within or adjacent to the work zone. Project engineers should evaluate and discuss detour and alternate routes with emergency service providers (fire, police, ambulances, etc.) so that response times may be reviewed and taken into account. Contractors are required to include emergency access plans as part of the WZTCP and coordinate with the emergency service providers.

Consideration must be given to detour routes that cross railroad crossings at grade. An increase in traffic volumes on the detour route may require the use of gates at the crossing. The WZA should be contacted when a detour route includes an at-grade crossing to determine the necessary traffic control.

6.04.01 Full Road Closures

Full road closures are the most positive separation of road users and workers. They must be evaluated and considered for projects with underground utility work, bridge demo, deck replacements, and complete reconstruction activities. Consider expedited work schedules to complete the work and return the road to the user as quickly as possible. Road closures also impact travel time as there may not be reasonable detour routes around the project site.

Detour routes for a full closure must also be reviewed for capacity, existing crash patterns, and signal timing that could contribute to additional crashes and delay.

In advance of a closure, lighted Type III barricades must be placed on the shoulder or behind curb at the nearest cross road in advance of the closure. R11-3 signing must be placed above and behind the Type III barricades.

At a road closure point, lighted Type III barricades must be placed across the entire closed area. R11-2 or other R11 series signs must be placed on or above and behind the Type III barricade in the center of the closure. Refer to MMUTCD Part 6 (Sections 6F.08- 09 and Figure 6F-3).

Areas that warrant additional protection from a hazard, or if traffic is found to be moving signs, the special provision for TEMPORARY WATER FILLED BASE SIGN SYSTEM may be utilized.

6.04.02 Directional Detours

Directional detours provide additional work space for part width construction. It

is recommended that these types of closures are evaluated in the same manner as complete roadway closures where a specific direction of travel may need to be detoured. Projects must be reviewed carefully to determine which direction of travel should be detoured. Impacts on road user travel and their ability to change their travel path must be Included in the review.

For non-freeway projects, it is recommended to detour traffic the same direction for the duration of the project. This provides motorists with consistent routes and travel paths as changing back and forth could lead to head-on traffic crashes. Consistency is critical for areas that have residential or business driveway access.

In business or residential areas, public feedback may be helpful in determining which direction to detour. Public input should be taken into consideration but engineering judgment should be utilized when making the final MOT selection.

Turning movements and existing capacity of the detour route, along with public input, should be a factor in the design. A detour route that has all right hand turns and free flow movements would be desirable over left hand turns.

Freeway projects have controlled access points so the need to maintain the same direction of traffic for the duration is not as critical for non-freeways. The traffic volumes and viable detour routes should be considered when determining which direction to maintain during the course of the project.

6.04.03 Ramp Closures

Ramp closures can provide separation of road users and workers and also reduce the amount of interaction between mainline traffic and entering traffic. Ramp closures should be evaluated when construction is occurring at or near the merge point and when merging locations will require a stop condition or visibility is impacted. These locations are known to contribute to congestion, backups, and rear end and side swipe crashes. Closing ramps may improve the safety and travel time of mainline traffic.

Design considerations should include requirements to prevent the closure of adjacent interchanges simultaneously. Consideration should be given to expedited work schedules to complete the work and return the ramp to the user as quickly as possible.

6.04.04 Detour Signing

The type and location of detour signing depends on the following factors:

- ADT
- Area traffic generators (i.e. commercial or institutional land uses nearby residential areas and transit stops).
- Time of year
- Project duration
- Other consideration: emergency operations, incidents, planned special events, etc.

Detour signing must be placed as described in the MMUTCD Part 6 (Sections 6F.19, 6F.20, 6F.28, and 6F.59). Guidance for freeway, ramps, non-freeway and local roads are summarized in Tables 6-8 and 6-9.

Cardinal directional signs (North, South, East, West) are required if both directions of the roadway are closed and detoured. If the detour route combines both directions, the cardinal direction sign may be eliminated. Detour signs posted on non-freeway routes at left turns should be posted at the near right and far left of the

intersection. On freeways, one-way, and/or divided roadways, detour signs should be placed on both sides of the roadway in the same direction.

When signing for a detour ahead or road closure ahead, adding a supplemental plaque is required when the sign is not on the roadway to be closed or detoured. A 2 x 2 foot route marker should be used or the road name can be spelled out if space allows as shown in Exhibits 6-18 and 6-19.

Exhibit 6-18:
DETOUR WITH ROAD NAME

Exhibit 6-19:
DETOUR WITH ROUTE MARKER

A. Sign Color and Sizes

Detour sign color is based on the parent route marker sign. The local road name must not extend past the edges of the M4-9 sign by more than 3 inches on either side. The letter size of the sign may need to be reduced to fit within these dimensions. If the road name consists of two words, they may be placed on two separate lines. For detour signs designed with route marker signs, use the standard sizes and colors as described in sections 2D of the MMUTCD.

The M4-8 "DETOUR" plaque must be used on top of all state route detours with the route marker designation. The M4-8 sign is always on an orange background with black letters. Additional information regarding route markers can be found in MMUTCD Part 2 .

EXHIBIT 6-20: DETOUR CLUSTERS

The addition of special sign designs may be appropriate for some projects to enhance the standard detour signing. These signs have an orange background with a black border and should include the route marker signs and arrows. The word "DETOUR" is not required for these signs as they are recognized as a construction detour sign.

EXHIBIT 6-21: SAMPLE DETOUR SIGNS

B. End Detour

END DETOUR (M4-8a) signs are recommended to end a detour route. If the detour is for a local route, the road name plaque must be placed above the M4-8a sign. If the detour route is a numbered route, the cardinal direction and the route plaque (if appropriate) is required below the M4-8a sign as detailed in exibhit 6-20.

C. Portable Changeable Message Signs (PCMS)

PCMS may be used for detours less than 72 hours in lieu of detour signing as determined by the Engineer.

Example:

Closing a low volume ramp overnight; place PCMS board in advance of ramp closure with the following messages:

Phase 1: EXIT XXX CLOSED AHEAD

Phase 2: USE EXIT XXX

OR

Phase 1: EXIT XXX CLOSED AHEAD

Phase 2: FRIDAY 9 PM -10 AM SATURDAY

Additional information regarding PCMS placement and messaging is provided in Appendix F and in the MMUTCD Part 6 (Section 6F.60).

TABLE 6-6: NON-TRUNK LINE DETOUR SIGNING DESIGN GUIDELINES

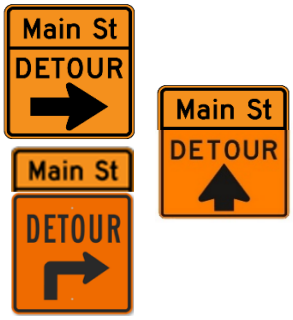
Detour Duration	Non-Trunk Line Detour	
	Signing	**Example** (*all road name signs to be paid for as Sign Type B Special)
< 24 hours	• M4-9 (R) (L) - Detour Sign with appropriate directional arrow at each decision point. • Or portable changeable message boards (6.04.04 Section C)	
24-72 hours	• M4-9 (R) (L) - Detour Sign with Road Name Plaque and appropriate directional arrow at each decision point. • Or portable changeable message board (6.04.04 Section C)	
> 72 hours	• M4-9 (R) (L) (U) - Detour Sign with Road Name Plaque and appropriate directional arrow at each decision point near right and far left corners of the intersection. • M4-9 (UL) (UR) - to be placed in advance of each turn. • An “up” pull through arrow should be required after each major intersection, and should be considered after each turn decision point.	

TABLE 6-7: TRUNK LINE DETOUR DESIGN SIGNING GUIDELINES

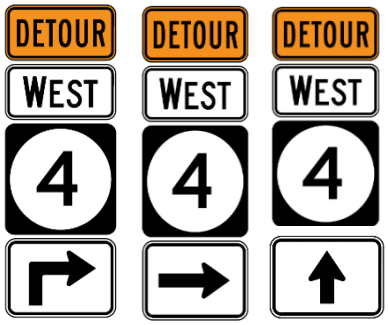
Detour Duration	Trunk Line Detours	
	Signing	**Example**
< 72 hours	• M4-8 Detour Plaque • M3-1, M3-2, M3-3, M3-4 Cardinal Directional Sign • M1-1, M1-2, M1-3, M1-4, M1-6 Route Marker Sign • M6-1(R)(L), M6-2(R)(L) Directional arrow at each turn or exit. • A PCMS may be used for simple detours (6.04.04 Section C)	
> 72 hours	M4-8 Detour Plaque • M3-1, M3-2, M3-3, M3-4 Cardinal Directional Sign • M1-1, M1-2, M1-3, M1-4, M1-6 Route Marker Sign with directional plaque must be placed in advance and at each turn. • M5-1, M5-2, M5-3, M6-1, M6-2, M6-3 Directional Arrow at each turn or exit • An “up” pull through arrow is recommended after each major interchange and after each turn or exit.	

TABLE 6-8 DETOUR SIGNING PLACEMENT GUIDELINES

Detour Signing Placement Guidelines			
Roadway	**Turning Detour Signing**	**Advance Turn Detour Signing**	**Pull Thru Detour Arrow Signing**
Non-Freeway	50 feet (min) before intersection spring point	500 feet (min) before intersection spring point.	500 feet (max) after intersection
Freeway	100 feet (min) before exit lane taper	1/2 Mile (min) before exit lane taper	500 feet (max) after lane merge taper
Ramps	50 feet (min) before spring point	500 feet (min) before spring point	N/A

6.05 GEOMETRIC DESIGN & SAFETY

Design engineers must design safety into all MDOT work zones and address safety considerations in all MOT's. Considerations include items such as vertical differentials, vertical / horizontal clearance, lane widths, etc. and must be evaluated when scoping and designing projects.

6.05.01 Lane Transitions and Widths

Existing lane widths should be maintained during construction when feasible. Consider the following factors when narrowing lanes or shifting traffic:

- Overall roadway width available
- Posted speed limit
- Traffic volumes through the project
- Number of lanes
- Length of project
- Duration of the lane width reduction
- Roadway geometry
- Percentage of commercial traffic
- Special vehicles such as campers and boats

Lane transitions, reduced lane width, and traffic control changes in conjunction with the proximity of temporary traffic control devices must be designed in a manner that does not result in an unexpected condition for the motorists.

Projects should have a minimum 11-foot lane, and any shoulder next to an open ditch should be at least 3 feet from the hinge point (2 feet paved with 1 foot aggregate preferred). If the required lane widths and shoulders cannot be maintained during the staging of a 3R / 4R freeway project, a work zone shoulder width variance request must be completed.

Submit variance request Form 5632 to WZA for review by the Traffic and Safety Statewide Alignment Team (TSSAT). The TSSAT will provide one of the following recommendations.

- The MOT design is acceptable based on the documentation provided and the project can proceed.
- The MOT design is acceptable, but additional mitigation methods, as noted by the review team, should be incorporated into the project, and the project can proceed.
- The MOT design is unacceptable and requires the project office to adjust the MOT design.

Shoulder delineation devices must be used as detailed in WZD-126. Flexible delineators, delineator panels, or flexible guardrail delineators must be used on narrow shoulders. Contact the WZA to discuss additional mitigation measures.

6.05.02 Shy Distance and Buffer Zones

Shy distance is defined as the distance from the edge of the travel lane to the nearest roadside object or traffic control device.

Lateral buffer zones provide additional space between the motorist and temporary traffic control devices, work zone operations, and equipment and materials. Lateral buffer spaces should be included anytime there is additional space. A 2-foot shy distance is optimal,

however, a 1 foot shy distance is acceptable. The TTCP must provide the lateral buffer zone or clearance dimension to be used during construction operations.

Longitudinal buffer zones are provided at the beginning of the work zone between the end of the temporary traffic control transition and the beginning of the active work area. The length of this buffer zone, defined in the maintaining Traffic Typicals.

In locations with intersecting side streets or business driveways, it may be safer to reduce the amount of buffer space below the typical layout to allow for a more defined work zone. If this occurs on a project, documentation explaining the reasons the typical length was reduced should be provided.

6.05.03 Work Zone Clear Zone

The contractor's operations may be exposed to errant vehicles that enter areas adjacent to the traveled way. A Work Zone Clear Zone (WZCZ) must be maintained by the contractor as part of the WZTCP to address storage of equipment, employee private vehicle parking, storage/stockpiling of materials, etc.

The WZCZ applies during working and non-working hours and will only apply to roadside objects introduced by the contractor's operations. If the equipment or materials cannot be relocated outside the WZCZ then the items must be delineated or attenuated with appropriate traffic control devices.

The WZCZ and buffer zone dimensions should be evaluated and increased where appropriate for horizontal curves, long downgrades, steep inclines and locations of high traffic volume.

See section 7.01.10 Clear Zone History of the MDOT Road Design Manual for detailed information on the WZCZ.

6.05.04 Vertical Under Clearance

It is critical to maximize the vertical under clearance on all construction projects. Any reductions below the required minimum structure height (Bridge Design Manual 7.01.08), to the existing vertical under clearance, must be posted on the Active Permit Restriction Bulletin System and signed on the construction project.

An orange on black W12-2 sign should be used. The TSC Permit Engineer or Agent can assist with the posting of any reductions to existing under clearance.

6.05.05 Lane Edges

Vertical differentials should be minimized, mitigated, or eliminated. Anticipated vertical differentials should be included in the project plans along with the requirements for warning the motorist. Section 812.03.I.5 of the MDOT Standard Specifications for Construction provides additional requirements for shoulders and vertical longitudinal joints while maintaining traffic.

Vertical differential treatments are shown in *Table 6-9: Lane and Edge Drop Treatments*. Uneven lane (W8-11) warning signs should be repeated after each intersection or interchange, and at additional locations as determined by the Engineer.

TABLE 6-9: LANE AND EDGE DROP TREATMENTS

Differential	Distance from the Active Traffic Lane	
	0 to 3 feet for shoulders or between directional traffic lanes*	3 to 8 feet
0 to < 2 inches without taper	Install shoulder drop-off signing or uneven lane signing	Install striped edge line Install Low Shoulder signing (optional)
2 to < 4 inches with 1:3 taper	Install shoulder drop-off signing or uneven lane signing	Install striped edge line Install Low Shoulder signing (optional)
2 to < 4 inches without taper	Install shoulder closed signing or uneven lane signing, and Install channelizing devices	Install Shoulder Closed signing Install channelizing devices
4 to < 12 inches with 1:4 taper	Install shoulder drop-off signing or uneven lane signing	Install striped edge line Install Low Shoulder signing (optional)
4 to < 12 inches with 1:3 taper	Install shoulder closed signing or uneven lane signing, and Install channelizing devices	Install shoulder Closed signing Install channelizing devices
4 to < 12 inches without taper	Install shoulder closed signing or uneven lane signing, and Install channelizing devices Install Type III barricades, at 20xS spacing	Install Shoulder Closed signing Install channelizing devices Install Type III barricades at 20xS spacing
12 inches or greater	Install barrier wall or reduce Channelizing device spacing**	Install Barrier wall or reduce channelizing device spacing*

* Standard Plan R-53 must be followed for barrier that is 0-26 inches from the drop-off, outside 26 inches follow Standard Plan R-126

** Use channelizing devices at a reduced spacing if mobility requirements on the project prohibit the use of barrier wall.

6.05.06 Freeway Ramps

When construction activities require ramp traffic to be maintained off existing alignment, design the temporary ramp alignment to meet a minimum design speed of 10 mph below posted speed prior to construction (Standard Plan R-113). Once the proposed ramp work is complete and can be opened to traffic, remove temporary traffic control devices that modified the freeway ramp traffic.

Placing a stop or yield condition for freeway entrance ramps should be avoided by supplying a merge area that is similar to the pre-work zone distance, during the project life. Consider temporarily closing the ramp to complete the necessary work.

If there must be a shortened gap requiring a stop or yield condition in the ramp area, minimize the amount of time the gap is shortened; expedite the work, try to avoid peak traffic times, and restore the ramp to a merge condition as soon as possible.

6.05.07 Relocating Traffic

Project scoping and design staff should verify the existing conditions and thicknesses to ensure the pavement will be able to handle the expected traffic volume (passenger & commercial). Pavement core samples should be taken to verify the condition of the pavement.

A. Road Way

When shifting traffic, review the roadway to ensure the integrity of existing features (i.e. drainage structures, culverts, handholes etc.) can support the expected traffic. The review should take place just before shifting traffic to verify the current pavement condition has not deteriorated or the design has not been modified.

Existing rumble strips should be evaluated for proximity to wheel paths and temporarily filled where appropriate. Determination and guidance is detailed in section 6.01.21.

B. Vertical and Horizontal Clearance

Vertical and horizontal clearances should be evaluated on shoulders in the same manner as the mainline as detailed in 6.05.04 Vertical under Clearance.

C. Objects within the clear zone

Objects within the clear zone should be identified using object markers. If feasible, object should be removed, otherwise they will need to be protected. Existing guardrail runs should be evaluated with the temporary edge of travel lane and adjustments should be included in the TTCP.

D. Shoulder Conditions

Existing lateral conditions and construction operations may result in a narrow shoulder while maintaining traffic. The project designer should evaluate the cost to pave additional shoulder width in these areas to improve safety and mobility.

All permanent shoulders or shoulder widening that will be used as temporary lanes, with construction speeds of 45 mph or greater, when traffic is shifted onto a shoulder that has been temporarily widened for maintaining traffic must incorporate the Safety Edge per *Frequently Used Special Provision, 12SP501BB*.

When temporarily widening a shoulder for maintaining traffic, the material used must be specified per *Frequently Used Special Provision, 12SP307A*

EXHIBIT 6-22: SAFETY EDGE

6.05.08 Value Engineering Change Proposals (VECP)

VECP's must consider the requirements of the Work Zone Safety and Mobility Policy in the analysis process, see FUSP 104C. Safety and mobility mitigation costs should be included in the analysis. When reviewing a VECP for approval all factors need to be looked at, including work site safety, which can be difficult to quantify but should be factored into the final discussion process. Simply reducing the lane widths to reduce the project cost should not be considered unless other tangible factors are gained by the width reduction.

It is common for offices to detail a timeframe for review and submittal of VECP's in the MOT SP. During the VECP process the TMP should be reviewed to determine if the proposed change has already been evaluated during the TMP development.

6.05.09 Transport Permits for Oversize (Weight, Width, Height, Length) Vehicles

Route availability is important for oversize vehicles. TSC staff must coordinate alternate route availability with the Transport Permit Unit in the Bureau of Development, Development Services Section, when placing restrictions on width, height or weight for oversized vehicles in construction work zones. Special attention "should be given to" routes "to/from" border crossings. Global signing may be utilized depending on the scope scale and complexity of the project. Contact information for Transport Permits may be found on the MiTRIP website.

6.05.10 Temporary Median Crossovers

The use of temporary median crossovers moves traffic away from work areas. Temporary median crossovers should be considered for freeway reconstruction projects and bridge partial/complete replacement projects. The following should also be considered:

- Cost of building and removing crossover
- Construction scheduling compared with the cost of part width construction
- Capacity and delay evaluations.
- On and off ramp locations
- Expedited work schedules
- Roadway geometry
- Drainage

Temporary median crossovers should be designed with the same requirements as the roadway. If permitted, the project manager may complete this design work and build the temporary crossovers as a separate advanced contract.

6.05.11 Traffic Control - Setup, Removal, and Stage Changes

All Traffic control, including pavement markings, for project set-up and removal must be considered during the development of the TTCP.

A. Traffic Switch

A traffic switch is defined as a change in the present traffic configuration which requires multiple lane lines and/or edge lines to be relocated to a new location and the old lines to

be abandoned or removed between construction stages or maintenance of traffic stages. There are times when conflicting pavement markings and sign information is unavoidable, but such occurrences must be minimized by accelerated work. The following factors should be analyzed when considering the time frames for night traffic switch operations:

- Local Crash Histories (with and without the work zone in the area)
- Traffic Speeds
- Traffic Volumes
- CO3 Mobility and Delay Analysis or Synchro Analysis
- Type of Work and Needed Traffic Control
- Duration of Work
- Residential and commercial concerns stated at outreach meetings during planning and design phases.

B. Advance Warning of Traffic Switch Operations

When performing traffic switch operations, it is important to notify the motoring public of changing conditions. When PCMSs are specified in the contract, it is recommended that they are moved in advance of the anticipated queue location. The message on the PCMS should state, *Traffic Switch Ahead*, and if anticipating traffic backups, a second message added, stating, *Be Prepared to Stop***,** should be placed on PCMS leading into the work zone. If the contract does not have PCMS specified in the contract, rigid static signs stating, *New Traffic Pattern Ahead,* should be utilized. Whether a traffic switch is performed during the day or night, special consideration needs to be given for motorists in the area of the queue.

C. Law Enforcement During Traffic Switch Operations

See Section 4.05, Work Zone Law Enforcement, for detailed information regarding how to include work zone enforcement into the contract. If a traffic switch is planned at night, MDOT should coordinate law enforcement presence into the contract. If law enforcement presence is not available at the time of the traffic switch, the operation will not to be allowed to be delayed and no extension of time will be approved. Coordination with law enforcement needs to take place during the project to keep them informed and enable them to anticipate the traffic switch operations.

6.05.12 Nighttime Traffic Switches

It is recommended that traffic switches are performed during daytime, off-peak hours if feasible when considering the overall project safety and mobility factors. If it is determined that traffic switches must be performed at night, based on the previous factors listed, a Temporary Traffic Plan (TTP) peer review should be conducted and approved by a team consisting of Region, TSC Traffic & Safety, and TSC Construction staff.

While a traffic switch operation is not specifically detailed in the project plans, Designers and Construction Engineers should carefully consider the time frames required for these operations. It is understood that due to mobility requirements, many of these operations should take place within the restrictions noted in the Special Provision for Maintaining Traffic.

Traffic switch operations, however, can be significant, and should be accounted for in the Progress Clause or the Special Provision for Maintaining Traffic. Lane closure restrictions for staged construction could be different than the requirements during traffic switch operations. Therefore, a separate section for traffic switch lane closure restrictions must be clearly defined with what applies during the traffic switch operations.

Construction staff is required to coordinate traffic switch operations with the contractor. It is not uncommon for the traffic switch operations to impact additional roadways or ramps, or take a substantial amount of time during non-peak traffic time frames. Flexibility is encouraged when reviewing and approving the traffic switch time frames, along with other operational logistics.

A. Nighttime Lighting for Traffic Switch Operations

Worker and motorist safety is a shared responsibility between MDOT and the contractor. When working at night, the lighting requirements as detailed in the Frequently Used Special Provision for Lighting for Night Work Specifications (12SP-812CC-01) must be established and deployed for the entire work zone. The appropriate lighting pay items must be included on projects requiring nighttime switches, or other night time work.

B. Lane Rental or Liquated Damage Assessments during Traffic Switch Operations

For the traffic switches to have the least impact on safety and mobility, language to address traffic switch operations and how assessments will apply for specific stages should be addressed in the *Maintenance of Traffic Special Provision and Progress Clause*. Allowable time frames should correspond with off-peak hours, and the contractor should be exempted from lane rental charges or liquidated damages when traffic is switched during the allowable time frames.

Include the following language as part of Progress Clause or Maintenance of Traffic Special Provision: “Traffic switch operations are exempt from rental or liquidated damage assessments for 8 hours for each traffic switch. Traffic switch operations are to take place within the allowable “Work Area Time Restrictions” as shown in the Maintenance of Traffic Special Provision.

6.06 WORK ZONES, INTELLIGENT TRANSPORTATION SYSTEMS (ITS) AND TECHNOLOGY

Safety and mobility within work zones and alternate routes can be greatly enhanced through the application of existing and emerging technologies and are referred to as ITS.

ITS systems can be used to display road user information in advance of the work zone to alter motorist behavior. This improves mobility, worker and public safety. ITS solutions can reduce the delay through and around a work zone by:

A. Monitoring and managing traffic

B. Collecting traffic data for near-real-time distribution to partner agencies and the media

C. Collecting traffic data for historical analysis to provide an evaluation of the effectiveness of a project’s TOP and to forecast traffic conditions for similar future projects.

D. Providing traveler information to allow motorists to modify their route.

E. Providing advanced notice of work zone and traffic conditions.

When designing or deploying a work zone related ITS system, region/TSC development and construction personnel should work with their region’s ITS representative and the Traffic Operations Center (TOC) covering the area. It is recommended that systems are reviewed and incorporated in areas where typical solutions (signing, rumble, strips, etc.) have not been successful or work zone impacts are non-typical.

When planning for the deployment of an ITS solution, sufficient time should be provided for the design, set-up, calibration, testing, and evaluation of the system. The proper selection of an ITS solution should be accomplished and

budgeted for during the scoping phases of the project. Bid items for the selected ITS solution(s) must be included in the project documents.

The FHWA document Work Zone Intelligent Transportation Systems Implementation Guide should be used to develop ITS strategies according to the following steps:

1. Assessment of Needs
2. Concept Development and Feasibility
3. Detailed System Planning and Design
4. Procurement
5. System Deployment
6. System Operation, Maintenance, and Evaluation

Before completing the proposed plan and strategies, contact the WZA for information on current specifications and new best practices or lessons learned to incorporate into the project.

6.06.01 Permanent Systems (cameras, detectors, signs)

A typical ITS traffic management system in Michigan includes the use of permanent dynamic message signs, closed-circuit TV cameras, permanent vehicle detector stations, road weather information systems and traffic operation centers are monitored 24 hours per day. Each system's components should be leveraged by construction staff to assist in work zone traffic management.

Region ITS staff should be contacted to determine the most up-to-date location of devices on the roadway.

TOC contact information is detailed below:

- STOC
- SEMTOC
- WMTOC
- BWBTOC

6.06.02 Temporary Portable Cameras

Temporary portable cameras can be placed at key areas within the work zone to provide a visual representation of current traffic conditions in and around the construction site. Construction staff may evaluate current traffic conditions and consider options for changes or additional traffic control measures based on the real-time traffic conditions.

Images from the temporary portable cameras can typically be viewed using a web-based application. In areas with a permanent traffic management system, the camera images may be included and monitored with images from the permanent camera stations.

Images from the temporary portable cameras can also assist with TIM and the quick clearance of incidents in work zones by providing accurate, real-time images to dispatch centers and emergency first responders.

6.06.03 Variable Speed Limits

Static speed limits may not reflect current conditions and could lead to decreased speed limit compliance and a high variance in the distribution of vehicle speeds. Variable speed limit systems use sensors to monitor prevailing traffic and weather conditions, posting appropriate advisory or regulatory speed limits on dynamic message signs. The use of variable speed limits can improve speed limit compliance and the safety of traffic flow by promoting and facilitating uniform traffic flow. State law currently prohibits the use of these devices in Michigan for regulatory variable speeds limits.

6.06.04 Stopped Traffic Advisory System

A queue detection system determines where queues begin upstream of a work zone, using a series of traffic detectors. PCMS and DMS (if available) can be used to communicate information to drivers in advance of the work

zone. This provides real-time messages and can reduce rear-end crashes significantly.

This system should be considered for back-ups or traffic delays outside of the work zone signing sequence, or in areas where the conditions are continuous or unexpected and cannot be avoided utilizing mitigation measures. The system can be modified to work for both short term and long-term work zones.

6.06.05 Dynamic Lane Merge Systems (Early/Late Merge)

These systems actively monitor and direct traffic streams, commonly in a two lane roadway, to merge traffic into a single lane to promote uniform traffic flow and speed. Uniform traffic flow and speed may reduce turbulence and aggressive driving that have adverse impacts on crash rates and mobility.

Dynamic lane merge systems use roadside detectors to monitor traffic flow and PCMS to relay real-time information. As queue increases are detected near the approach to a lane closure, the system regulates merging traffic by providing information and direction to motorists, requiring either an early or late merge. Dynamic lane merge systems:

- Reduce confusion when merging
- Reduce aggressive driver behavior
- Reduce queue lengths
- Increase work zone capacity
- Reduce crashes

6.06.06 Highway Advisory Radio (HAR)

HAR systems use a combination of radio equipment and signs that broadcast real-time traffic information and construction updates and messages using a radio frequency.

The system may be a permanently located transmitter or a portable trailer mounted system that can be moved from location to location. When properly deployed, monitored, and maintained, HAR systems provide motorists with useful, timely information.
To be effective, messages provided on a HAR system must be accurate and timely. If a HAR system is not available in your location, local media outlets may provide the same benefits.

6.06.07 Portable Traffic Detectors/Sensors

Portable traffic detectors measure traffic volumes, speeds, and vehicle classifications. This information can be used as part of a larger system including real time information systems, dynamic lane merge systems, queue detection systems, and permanent ITS systems.

Portable detectors and sensors may be used for standalone applications such as project websites, collecting real-time traffic data for distribution, and historical traffic data for work zone performance analysis.

6.06.08 Ramp Metering

A ramp metering system includes traffic signals on freeway entrance ramps that help regulate traffic flow and promote uniform flow of traffic onto a freeway. Traffic flow regulation can minimize disruptions and traffic turbulence by regulating the gaps between vehicles that enter a freeway.
An effective ramp metering program would likely include more than one ramp or interchange location. Benefits are maximized by taking a systems approach. Proper geometry is critical and must be provided to ensure the signal system functions properly. This could be cost prohibitive for temporary use in construction projects. In addition, law enforcement support is needed with ramp metering systems to maximize effectiveness.

6.06.09 Information Response Systems

A. Trucks Entering, Crossing, and Exiting

Designed to advise the motorist of potential contractor interaction with intended travel paths that may cause a motorist to slow or stop at specific locations within the work area. Locations should be identified through the use of additional warning signs.

B. Traffic Speed Trailers

Designed to advise motorists of their speed in relation to the work zone speed limit. Traffic speed trailers provide real time feedback and are a proven tool to increase speed compliance in the work zone. Law enforcement placed in or near the work zone also provides an effective speed measure.

C. Work Space Intrusion

Designed to advise workers of traffic intruding into the work zone, providing advance warning for workers to evade an intruding vehicle. Positive protection techniques should be considered before attempting to use intrusion warning systems. Although these systems are designed to warn of an errant vehicle, many motorists intentionally intrude the work zone to avoid delays, access driveways, intersections, ramps, etc. This may cause the alarm to sound unnecessarily, causing workers to ignore future alarms. Designers should consider other applications of positive separation before considering the use of intrusion alarms.

D. Oversize Vehicle

Oversize vehicle warnings should be considered for use when the roadway cross section places motorists, especially commercial traffic, into close proximity to fixed objects due to lane width restrictions, overhead restrictions, or in corridors that have previous history of over dimension crashes.

6.06.10 Additional ITS Resources

For more information on ITS systems, visit smarter work zone at workzonesafety.org and the FHWA document Work Zone Intelligent Transportation Systems Implementation Guide.

CHAPTER 7

WORK ZONE SAFETY AND MOBILITY ON FEDERALLY FUNDED LOCAL AGENCY PROJECTS

7.01 INTRODUCTION AND PURPOSE

This policy is intended to be used by Local Agencies (LA's) within the State of Michigan as a guide as they plan and design their individual construction projects.

This policy is intended to be followed by LA's for construction of all projects which are funded in part or in whole with Federal funds, and for all projects that propose construction work on MDOT-owned facilities or are located within MDOT owned right-of-way. In accordance with Federal regulations, this policy will be periodically reviewed for effectiveness and applicability, and revised or updated as necessary.

The primary goal of the WZS&M Rule and the WZS&M Policy is to reduce crashes and manage traffic congestion due to construction work zones. To accomplish these goals, the Local Agency (LA) prepares a Transportation Management Plan (TMP), which provides for consistent consideration of the safety and mobility impacts of work zones, as well as developing strategies and plans to reduce work zone impacts on all projects.

A TMP is required for all Federal Aid Highway projects which are funded in part or in whole with Federal funds and proposed construction on MDOT owned facilities or are located within MDOT owned right of way.

Local Agency Program compliance was mandated on all Federal aid projects by January 1, 2009.

7.02 LOCAL AGENCY POLICY BACKGROUND INFORMATION

For purposes of the WZS&M Policy, a Significant Project is defined as a project or work zone which, without proper traffic control and mitigation efforts, would cause "unreasonable delay, inconvenience, or risks" to road users, and road workers, residents, businesses, or the community.

In 2009, a subcommittee consisting of representatives of the County Road Association of Michigan (CRAM), now known as the County Road Association (CRA), the Michigan Municipal League (MML), Federal Highway Administration – Michigan (FHWA), and MDOT determined that all local agency projects that are constructed using Federal or State transportation funds are Significant, for purposes of the Work Zone Safety and Mobility (WZS&M) policy.

The subcommittee determined that LA's currently comply with the intent of the WZS&M requirements as part of the project planning and design process, including:

- Conducting public information dissemination, informing interested or affected stakeholders of the upcoming project, and conducting public information meetings.
- Notifying representatives of public utilities, emergency service providers, and public safety agencies of the construction project that will take place.
- Determining how the project will affect day-to-day public services and activities, and any special considerations that must be included

in the construction project to accommodate these services and activities.

- Considering how each project will affect or be affected by local civic events.
- Determining the effect of the project on school activities including school bus routes.
- Meetings with MDOT representatives if any proposed work on the project will be completed in the MDOT trunkline right of way.

Also, construction documents prepared for LA's projects typically include the following items:

- Construction plan sheets representing the maintaining traffic plan, which consist of at least locations and descriptions of temporary signing and traffic control devices.
- If required for the project, construction plan sheets showing locations of detour routes.
- Special provisions for maintaining traffic during construction.
- Pay items and quantities for use during construction.

The subcommittee prepared the Local Agency Program WZS&M guidance, which was approved by CRAM, MML, and MDOT, and concurred with by FHWA. This guidance document includes several checklists that local agencies use to document its planning, public information, design, monitoring, and revision efforts during the entire course of its construction project. The guidance is posted on the MDOT LAP website at:

http://www.michigan.gov/documents/mdot/mdot_WZSM_policy_FINAL_AS_APPROVED_BY_CRAM120808_259537_7.pdf

7.03 IMPLEMENTING THE LOCAL AGENCY WZS&M POLICY

To meet the requirements of this segment of the policy, LA's document how the policy requirements were addressed, using Pages APP I-1 through APP I-5 of the checklist included in the guidance document on the LAP website, at the above link.

The programming application (MDOT Form 0258, 0259, or 0260) and the WZS&M checklists are reviewed at the Grade Inspection meeting, which is conducted for the project by the MDOT Local Agency Program (LAP) Staff Engineer. Copies of the checklists are kept in the local agency's permanent project file.

The Local Agency WZS&M policy requires LA's to monitor and control traffic in and around the work zone during construction, and that LA's revise or improve the traffic control elements during construction. Examples include:

- Actively monitoring traffic patterns on detour routes, alternate routes, and other side streets during construction, including any change in the number of incidents and accidents, and determining whether these events were caused by or affected by the construction project.
- Meetings with the construction team, including contractors, subcontractors, construction engineers, and inspectors.
- Providing updates on the construction progress at public meetings and on web sites.
- Receiving communications and other input from affected users during the

construction period, either through predetermined public progress meetings, or indirect communications such as email, letters, and phone calls.

- Using the contract modification process to adjust or modify the Maintaining Traffic plan and construction pay items as necessary for such items as revising the number and types of signs, providing additional flaggers, modifying signal timing, or creating or modifying the alternate or detour route.

To meet the requirements of this segment of the policy, LA's document how the policy requirements were addressed, using Pages APP I-6 and APP I-7 of the checklist included in the guidance document on the LAP website, at the above link.

Additional information and reference material is available on the following websites:

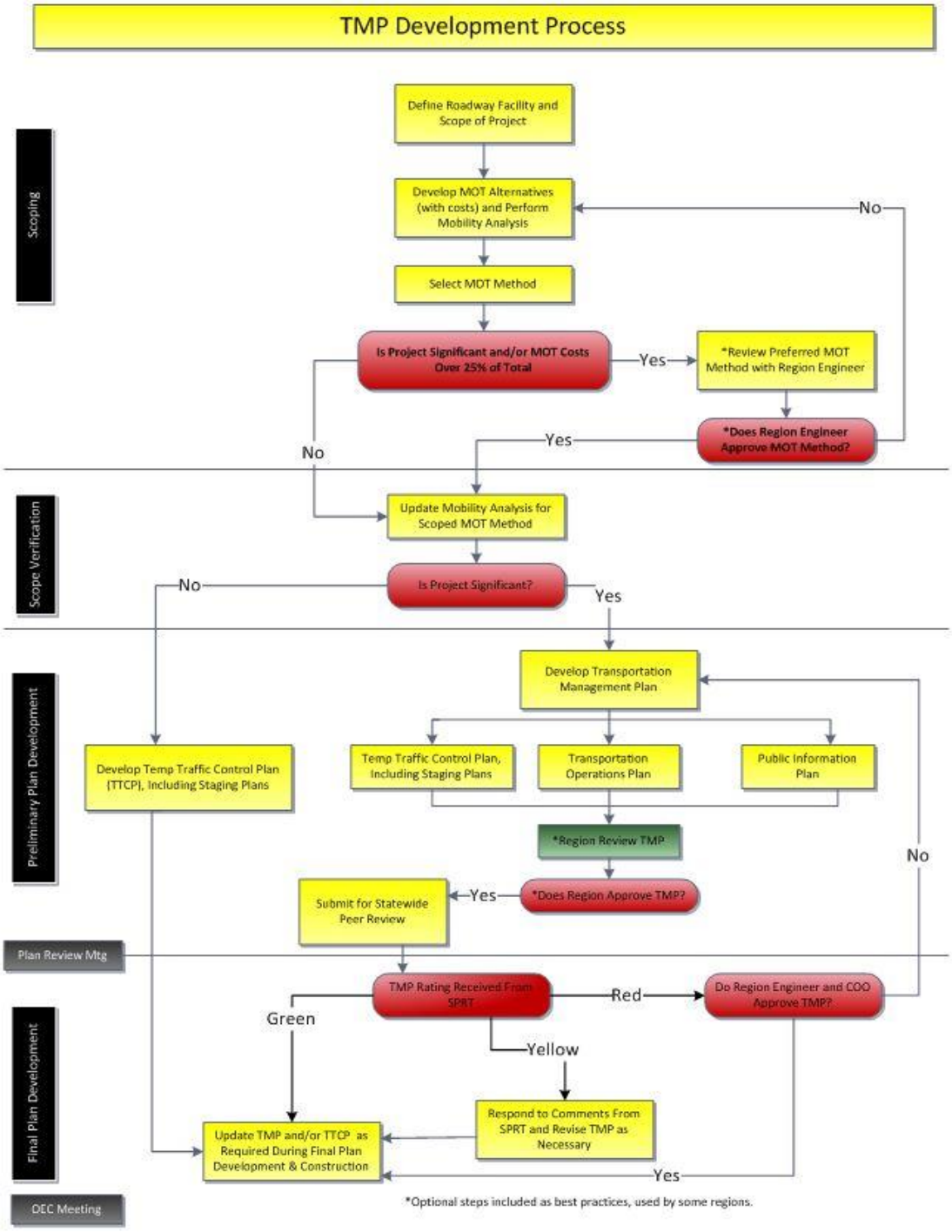
- MDOT Local Agency Program
- FHWA

7.04 RECORDS RETENTION

Finally, the Local Agency WZS&M policy requires LA's to update the checklists as necessary during construction and keep these documents in its construction files. Information and documentation relating to detour and alternate routes should be recorded on the Inspector's Daily Report. The records are not intended to be submitted to MDOT, but are subject to MDOT and FHWA auditing.

APPENDIX A

PROJECT DEVELOPMENT PROCESS



TMP Development Items

Task	Planning	Scoping	Development		Construction	
			Non-Significant	Significant	Non-Significant	Significant
Temporary Traffic Control Plan (TTCP)	❖	❖	❖	❖	❖	❖
MOT Typicals			•	•	•	•
Detours Routes	•	•	•	•	•	•
Multi-Modal Considerations	•	•	•	•	•	•
Preliminary Construction Costs	•	•	•	•	•	•
WZTCP					•	•
Traffic Operations Plan (TOP)	❖	❖	❖	❖	❖	❖
Work Zone Mobility Analysis	✓	✓	✓	✓	✓	✓
Traffic Data Information	•	•				
Travel Time Analysis	•	•	•	•	•	•
Queue Lengths			•	•	•	•
User Delay Costs	•	•	•	•	•	•
Existing Operations Analysis		✓	✓	✓	✓	✓
Travel Time Analysis		•	•	•	•	•
Existing Crash Analysis		•	•	•	•	•
Work Zone Crash Analysis				•		•
Operational Factors Analysis		•	•	•	•	•
Non-Motorized Facilities		•	•	•	•	•
Alternatives Analysis		✓	✓	✓	✓	✓
Travel Time Analysis		•	•	•	•	•
Queue Lengths			•	•	•	•
User Delay Costs		•	•	•	•	•
MOT Cost Estimate		•	•	•	•	•
Preliminary Construction Costs		•	•	•	•	•
Determine Project Significance	✓	✓	✓	✓	✓	✓
Project Mitigation Measures				•		•
Work Zone Schedule and Incentives			•	•	•	•
Agency Coordination	✓	✓	✓	✓	✓	✓
Public Information Plan (PIP)			❖	❖	❖	❖
Agency Coordination			•	•	•	•
Public/Stakeholder Information			•	•	•	•
Methods of Delivery			•	•	•	•
Performance Assessment Plan (PAP)					❖	❖
Work Zone Monitoring					•	•
Work Zone Audit Report					•	•
Construction Zone Check List					•	•
Traffic Delay					•	•
Crashes					•	•
Non-Motorized Facilities					•	•

Project Checklists

- ☐ **Planning**
- ☐ **Scoping**
- ☐ **Development**
- ☐ **Construction**

Yes	No	N/A	**Transportation Management Plan** *All LAP projects are required to complete a TMP. Non-significant projects require only the completion of a TTCP; however a TOP and PIP are recommended where appropriate.*
☐	☐	☐	Temporary Traffic Control Plan (TTCP)
☐	☐	☐	Traffic Operations Plan (TOP)
☐	☐	☐	Public Information Plan (PIP)

Yes	No	N/A	**1. Project Significance** *The threshold criteria to determine project significance is travel time as outlined in the Work Zone Safety and Mobility Manual.*
☐	☐	☐	Significant
☐	☐	☐	Non-Significant

Yes	No	N/A	**2 .Project Information**
☐	☐	☐	Project Overview
☐	☐	☐	Summary of Project Scope
☐	☐	☐	Route and local Name
☐	☐	☐	Location (City, Township, Village, etc.)
☐	☐	☐	Control Section and Job Number
☐	☐	☐	Point of beginning (POB) and point of ending (POE), station and description
☐	☐	☐	Vicinity Map
☐	☐	☐	Letting Date
☐	☐	☐	Construction Dates/Duration
☐	☐	☐	Construction Cost

Yes	No	N/A	**3. Facility Description**
☐	☐	☐	Functional Classification
☐	☐	☐	National Truck Network Route
☐	☐	☐	Speed Limit
☐	☐	☐	Number of Lanes
☐	☐	☐	Lane Widths
☐	☐	☐	Shoulder Width (paved)
☐	☐	☐	Shoulder Width (unpaved)
☐	☐	☐	Adjacent area classification (commercial, residential, historic, etc.)
☐	☐	☐	Roadway geometry (median, boulevard, undivided, etc.)
☐	☐	☐	On-street Parking
☐	☐	☐	Sidewalks/Shared Use Path
☐	☐	☐	Bike Lane/Cycle Track
☐	☐	☐	School Bus/Transit Operations
☐	☐	☐	AADT (vpd)
☐	☐	☐	ADT (vpd) –During Construction i.e. summer
☐	☐	☐	Background Growth Rate
☐	☐	☐	Directional Distribution (%)
☐	☐	☐	% Commercial
☐	☐	☐	Peak Hour
☐	☐	☐	Peak Hour Volume (vph)
☐	☐	☐	Traffic generators
☐	☐	☐	Traffic signals

Yes	No	N/A	4. Existing Operations
☐	☐	☐	Roadway Capacity (vphpl)
☐	☐	☐	Volume/Capacity
☐	☐	☐	Peak Hour Level of Service (LOS)
☐	☐	☐	Existing Peak Travel Time
☐	☐	☐	Peak Hour LOS

Yes	No	N/A	5. Temporary Traffic Control Plan
☐	☐	☐	Construction Staging
☐	☐	☐	Special Provision for Maintaining Traffic
☐	☐	☐	MDOT Maintaining Traffic Typicals
☐	☐	☐	Staging Typical Cross-Sections
☐	☐	☐	Detour Routes (identify routes)
☐	☐	☐	Traffic Signals (Signal timing modifications, temporary signals)
☐	☐	☐	Multi-modal considerations (mitigation strategies for all transit, pedestrian and bicycle impacts)
☐	☐	☐	Preliminary Maintaining Traffic Costs
☐	☐	☐	WZTCP

Yes	No	N/A	6. Traffic Operations Plan
			A. Work Zone Operations
☐	☐	☐	Work Zone Speed Limit
☐	☐	☐	Number of Lanes
☐	☐	☐	Lane Widths
☐	☐	☐	Shoulder Width (paved)
☐	☐	☐	Shoulder Width (unpaved)
☐	☐	☐	Buffer Space
☐	☐	☐	Peak Hour Volume (vph) during construction i.e. summer
☐	☐	☐	ADT (vpd) –During Construction i.e. summer
☐	☐	☐	Travel Time Analysis
☐	☐	☐	Intersection Analysis
☐	☐	☐	Crash Analysis
☐	☐	☐	Diversion Rates (explanation of anticipated diversions or reductions in traffic volumes)
☐	☐	☐	Detour Routes (travel time delay, route capacity, intersection operations, intersection delay and queue lengths)
☐	☐	☐	Commercial/private access impacts
☐	☐	☐	Emergency services access
☐	☐	☐	Environmental issues
☐	☐	☐	Noise and/or work ordinance restrictions (local laws)
☐	☐	☐	Over height clearance conflicts
☐	☐	☐	Over wide clearance conflicts
☐	☐	☐	Railroad crossing
☐	☐	☐	Roadside conflicts or hazards
☐	☐	☐	School bus/transit access
☐	☐	☐	Utility conflicts
☐	☐	☐	Special events
☐	☐	☐	Commercial/private access impacts
☐	☐	☐	Emergency services access
☐	☐	☐	Environmental issues

Yes	No	N/A	**B. Work Zone Alternatives Analysis** *The alternatives analysis should provide advantages, disadvantages and a conclusion regarding the alternative why it was/not chosen.*
☐	☐	☐	Travel Time Analysis
☐	☐	☐	Intersection Analysis
☐	☐	☐	Detour Routes
☐	☐	☐	User Delay Costs
☐	☐	☐	Temporary Traffic Control Cost

Yes	No	N/A	**C. TOP Mitigation Strategies**
☐	☐	☐	Demand Management: Exhibit 2-6
☐	☐	☐	Work Zone Safety: Exhibit 2-7
☐	☐	☐	Corridor/Network: Exhibit 2-8
☐	☐	☐	Incident Management: Exhibit 2-9

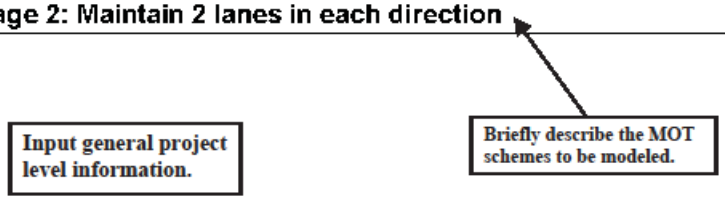
Yes	No	N/A	**7. Public Information Plan**
☐	☐	☐	Agency Coordination
☐	☐	☐	Public/Stakeholder Information
☐	☐	☐	PIP Strategies-Public Awareness: Exhibit 2-10
☐	☐	☐	PIP Strategies -Motorist: Exhibit 2-11

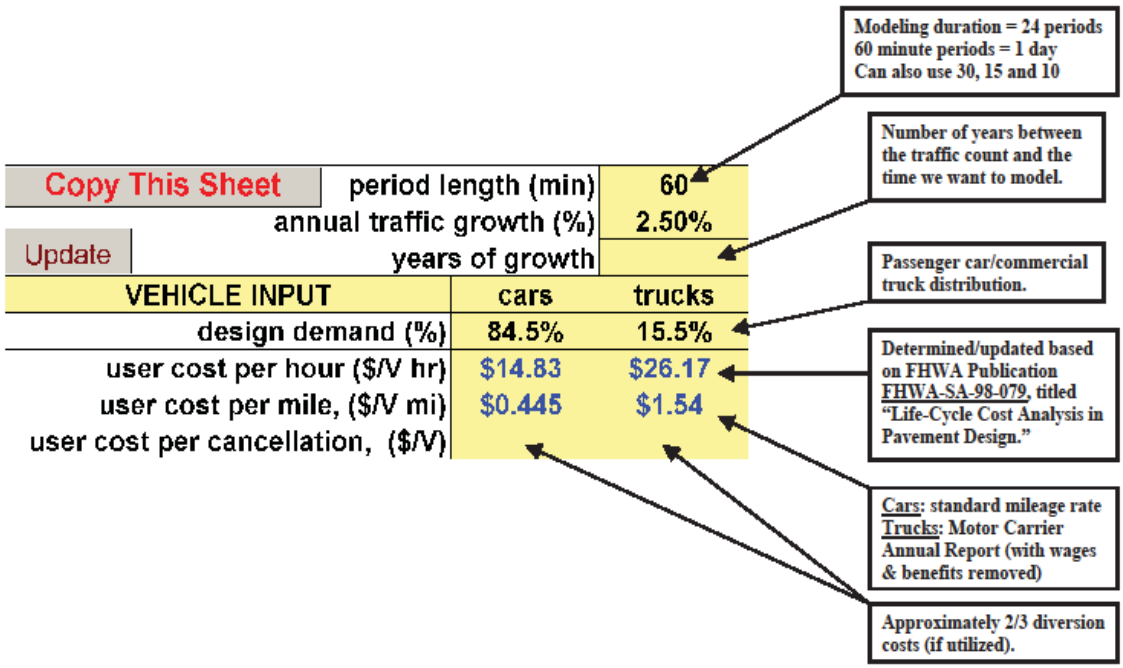
APPENDIX B

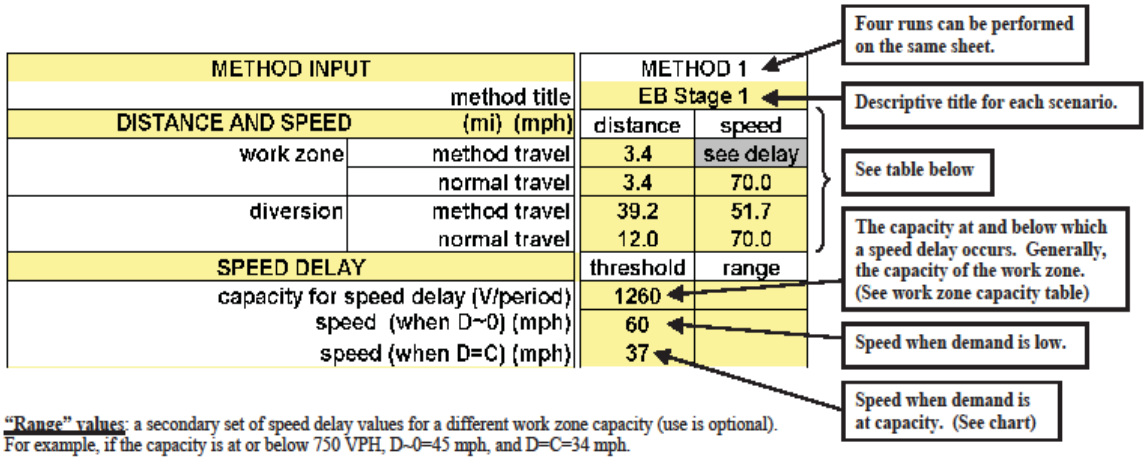
MOBILITY ANALYSIS TOOL

Traffic Tab

PROJECT INFORMATION			REPORT INFORMATION	
PROJECT TITLE	I-69 From Irish Rd to M-15		REPORT TITLE	DETAILED USER COST REPORT SUMMARY SHEET
Paste Values	C.S.	25084	DIVISION	C&T
	JOB #	56984	REPORT BY	BK
	START DATE		REPORT DATE	3/11/2005
NOTES:	Stage 1: Maintain 1 EB lane and 2 WB lanes Stage 2: Maintain 2 lanes in each direction			




Copy This Sheet
period length (min)
60
annual traffic growth (%)
2.50%
Update
years of growth
VEHICLE INPUT
cars
trucks
design demand (%)
84.5%
15.5%
user cost per hour ($/V hr)
$14.83
$26.17
user cost per mile, ($/V mi)
$0.445
$1.54
user cost per cancellation, ($/V)
Modeling duration = 24 periods
60 minute periods = 1 day
Can also use 30, 15 and 10
Number of years between the traffic count and the time we want to model.
Passenger car/commercial truck distribution.
Determined/updated based on FHWA Publication FHWA-SA-98-079, titled "Life-Cycle Cost Analysis in Pavement Design."
Cars: standard mileage rate
Trucks: Motor Carrier Annual Report (with wages & benefits removed)
Approximately 2/3 diversion costs (if utilized).

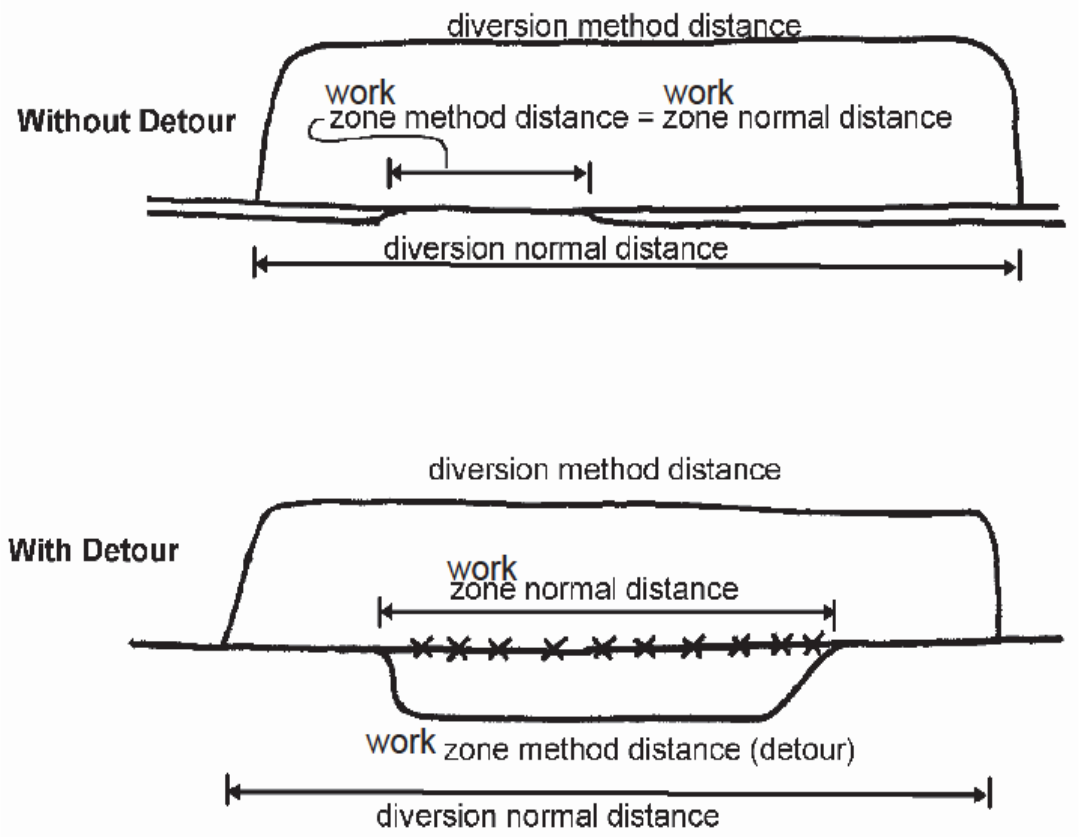


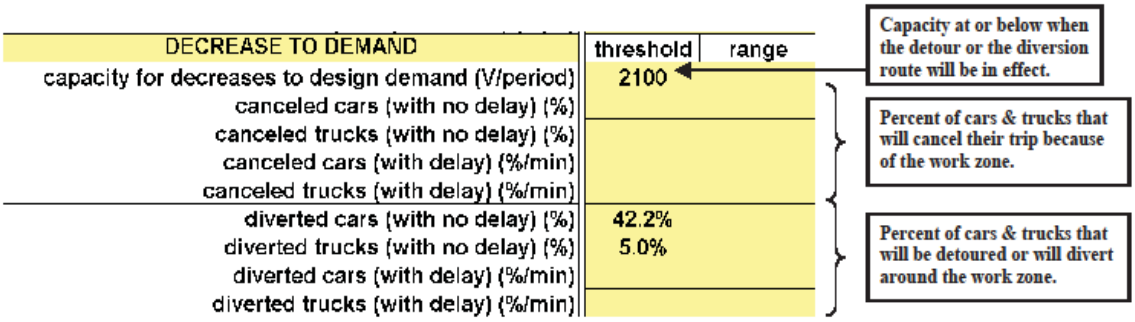
"Range" values: a secondary set of speed delay values for a different work zone capacity (use is optional). For example, if the capacity is at or below 750 VPH, D~0=45 mph, and D=C=34 mph.

Work zone method travel distance & speed	Distance each vehicle will travel through the work zone during construction, or a required detour around the work zone, if present. The speed vehicles travel through the work zone during construction is based on conditions that vary with demand and capacity in the work zone. This is calculated by CO^3 based on SPEED DELAY input above.
Work zone normal travel distance & speed	Distance and average speed each vehicle will travel if there is no construction, no work zone.
Diversion method travel distance & speed	Length and average speed of the most common alternate route vehicles will select to avoid going through the work zone or a required detour around the work zone. If there are several alternate routes, it is the average of the comparable lengths and average speeds, weighted by the number of vehicles expected to take each of them.
Diversion normal travel distance & speed	The distance each vehicle would travel if there were no work zone and the vehicle did not divert to an alternate route, and the average speed vehicles travel over the diversion normal travel distance, when there is no work zone.

See next page for a visual representation of the above table.

The average distance and speed can be calculated by using the "routes" tab in CO^3. See instructions later in this document.


Without Detour
diversion method distance
work
zone method distance = zone normal distance
work
diversion normal distance
With Detour
diversion method distance
work
zone normal distance
work zone method distance (detour)
diversion normal distance

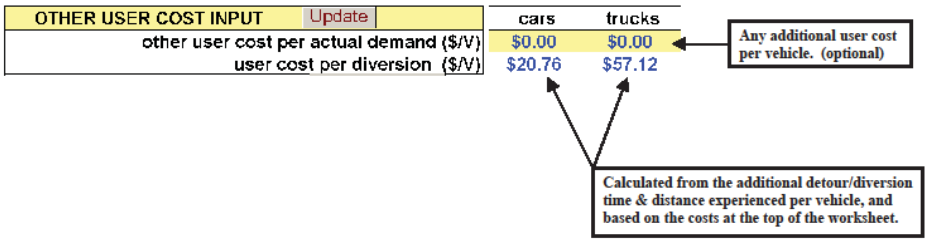


With delay? or with no delay?

"with no delay" – regardless of how long users believe they will be delayed, this percent of drivers will cancel, divert or be detoured around the work zone.

"with delay" – drivers tolerate delay time differently. Generally, the longer the delay, the more drivers who will find their own way around a work zone. Thus, for every minute of work zone delay, this percent of drivers will cancel, divert or be detoured around the work zone. For example, your diverted cars (with delay) value is 5% per minute. If work zone delay is 4 minutes, 20% of cars will divert.

"Range" values: a secondary set of diverted/canceled percentages for a different work zone capacity (use is optional). For example, if the capacity is at or below 1400 VPH, more vehicles are likely to divert around the work zone or cancel their trips.



This can be changed to examine NB & SB or EB & WB.

To examine directional weekday & weekend traffic, copy the traffic sheet to model the other bound.

PERIOD INPUT			backup at start (V)		0	0
	weekday	weekend	weekday	weekend	weekday	weekend
period	historical demand		design demand		capacity	
(hr)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)	(V/period)
12 A	260	622	260	622	1260	1260
1 A	208	379	208	379	1260	1260
2 A	182	352	182	352	1260	1260
3 A	208	244	208	244	1260	1260
4 A	208	208	208	208	1260	1260
5 A	416	416	416	416	1260	1260
6 A	909	909	909	909	1260	1260
7 A	1351	1351	1351	1351	1260	1260
8 A	1247	1247	1247	1247	1260	1260
9 A	1117	1117	1117	1117	1260	1260
10 A	1091	1407	1091	1407	1260	1260
11 A	1221	1597	1221	1597	1260	1260
12 P	1221	1921	1221	1921	1260	1260
1 P	1377	1840	1377	1840	1260	1260
2 P	1844	2030	1844	2030	1260	1260
3 P	2312	2312	2312	2312	1260	1260
4 P	2519	2519	2519	2519	1260	1260
5 P	2493	2493	2493	2493	1260	1260
6 P	1662	1840	1662	1840	1260	1260
7 P	1117	1488	1117	1488	1260	1260
8 P	935	1218	935	1218	1260	1260
9 P	857	920	857	920	1260	1260
10 P	701	785	701	785	1260	1260
11 P	519	731	519	731	1260	1260
Total	25973.63	29944.4	25974	29944	30240	30240

The number of vehicles backed up at the start of the first period being modeled. (optional) (12A in this example)

24 time periods can be modeled. (24 hours shown)

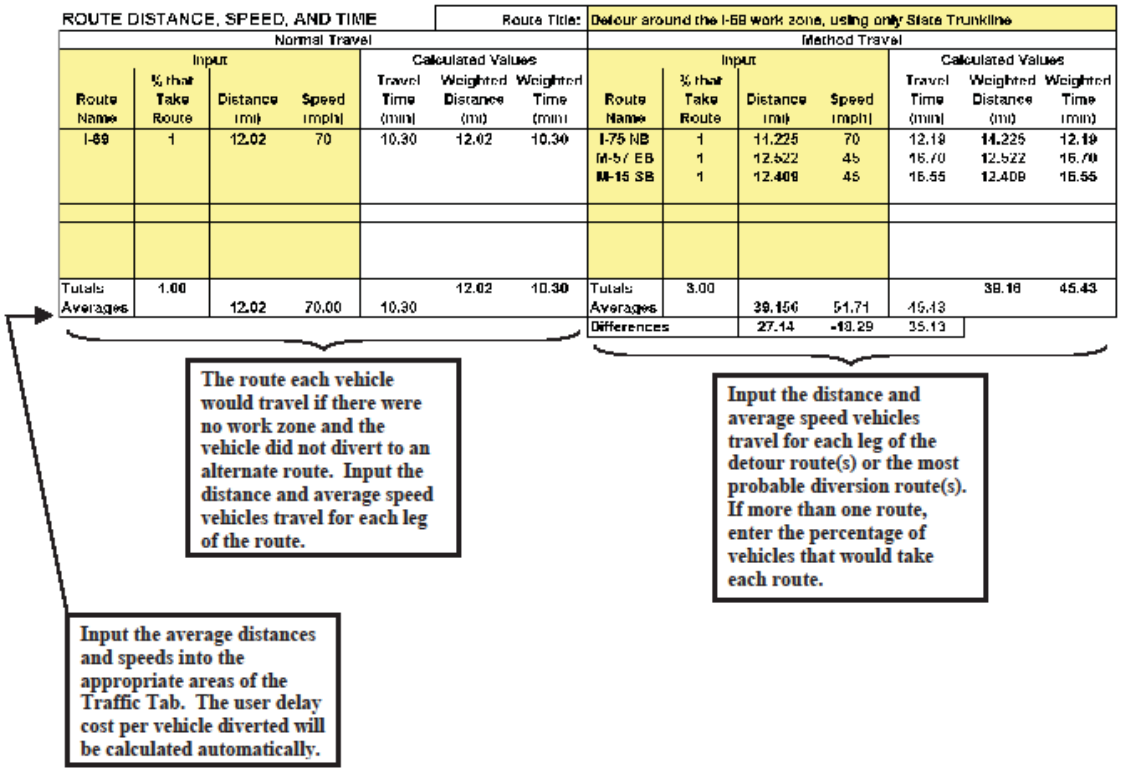
Optionally you can use 10 min, 15 min or 30 min time periods, if you have traffic counts with that breakdown.

Hourly work zone capacity.

Can be varied for every time period, depending on the number of lanes open during that period.

Actual hourly traffic counts.

Aged hourly traffic counts, based on the growth rate and years of growth. (optional)



ROUTE DISTANCE, SPEED, AND TIME

Route Title: Detour around the I-68 work zone, using only State Trunkline

Normal Travel							Method Travel						
Input				Calculated Values			Input				Calculated Values		
Route Name	% that Take Route	Distance (mi)	Speed (mph)	Travel Time (min)	Weighted Distance (mi)	Weighted Time (min)	Route Name	% that Take Route	Distance (mi)	Speed (mph)	Travel Time (min)	Weighted Distance (mi)	Weighted Time (min)
I-68	1	12.02	70	10.30	12.02	10.30	I-75 NB	1	11.225	70	12.19	11.225	12.19
							M-57 EB	1	12.522	45	16.70	12.522	16.70
							M-15 SB	1	12.409	45	16.55	12.409	16.55
Totals	1.00				12.02	10.30	Totals	3.00				36.16	45.43
Averages		12.02	70.00	10.30			Averages		39.156	51.71	45.43		
							Differences		27.14	-18.29	35.13		

The route each vehicle would travel if there were no work zone and the vehicle did not divert to an alternate route. Input the distance and average speed vehicles travel for each leg of the route.

Input the distance and average speed vehicles travel for each leg of the detour route(s) or the most probable diversion route(s). If more than one route, enter the percentage of vehicles that would take each route.

Input the average distances and speeds into the appropriate areas of the Traffic Tab. The user delay cost per vehicle diverted will be calculated automatically.

Press the "Compute" button for each column, located between the 'other user cost input' and the 'period input' sections of the worksheet.

SUMMARY OUTPUT	traffic method	EB Stage 1	
	direction	weekday	weekend
	total user cost	$254,016	$299,866
	user cost of delays	$50,226	$64,921
	user cost of decreases	$203,790	$234,945
	maximum backup (V)	876	906
You can copy these values into Impact Sheet	maximum backup length (lane mi)	5.0	5.1
	maximum delay (min.)	44.3	45.8
	average delay, except diversions (min)	10.5	11.7
	total delay, except diversions (V hr)	2877	3719
	total vehicles canceled(V)	0	0
	total vehicles diverted (V)	9463	10910
	total decrease in demand (V)	9463	10910
	% decrease in demand	36.4%	36.4%
	delay per diverted vehicle (min)	35.1	35.1
	total diversion delay (V hr)	5542	6389
	average delay, including diversions (min)	19.4	20.3
	total delay, including diversions (V hr)	8419	10108
	user cost / design demand	$9.78	$10.01
	delay cost / actual demand	$3.04	$3.41
Aut ON Prin ON Nov OK	validity of output	VALID	VALID

From the speed delay of going through the work zone.

From the vehicles that diverted or canceled.

This length is per lane mile. If the capacity reflects more than one lane, divide this length accordingly.

A check on whether the summary output shown was computed from the input shown. VALID indicates summary output shown was computed using the input shown. NOT VALID indicates one or more input values have been changed since the current summary output was computed.

APPENDIX C

TMP EXAMPLES AND BEST PRACTICES

For ProjectWise access please visit the

MDOT ProjectWise Website

This page will provide links to ProjectWise

Significant Project Examples

Non-Significant Project Examples

TMP Best Practices

APPENDIX D

TRAVEL TIME DELAY SHEET

REGION:	IN: TSC AREA	TSC INSPECTING:
PROJECT #:	HIGHWAY:	ORIGINAL DELAY ESTIMATE: MIN.

SKETCH:

DATE	TIME	DIRECTION	APPROX. MILE POINT	MILES OF SLOWDOWN*	MIN. SPENT IN SLOWDOWN**	PRE-CONSTRUCTION ZONE TRAVEL TIME AT POSTED SPEED LIMIT IN MINUTES ***	DELAY= DIFF. OF TIMES	MEASURED BY

NOTES RE: SPECIFIC CIRCUMSTANCE IN ABOVE OBSERVATIONS:

* FROM ODOMETER OR D.M.I. FROM INITIAL DECELERATION UNTIL POSTED SPEED RESUMED
** FROM STOPWATCH FOR ABOVE DISTANCE

*** $\frac{\text{60 Minutes Per Hour}}{\text{Posted Speed Limit MPH}}$ X Miles of Slowdown = Minutes

APPENDIX E

2006 GUIDELINES TO ESTABLISH SPEED LIMITS IN WORK ZONES

Work Zone Speed Limit Procedure

Condition 1 – Roadside Activity

Work activities, workers, materials, and equipment that are **more than 15 ft** from the edge of the traveled way.

Typical Applications

Construction	Utility work
Cleaning drainage	Reworking ditches
Landscaping work	Fencing work
Structural work	

Speed Limit

No reduction

There should not be a reduction to the regulatory speed limit, unless unusual situations create hazardous conditions for motorists, pedestrians, or workers. A temporary Traffic Control Order (TCO) is required **prior** to the start of work when speed reductions are required.

Work Zone Speed Limit Procedure

Condition 2 – Roadside Activity

Work activities, workers, materials, and equipment that encroach on the area closer than 15 ft, but not closer than 2 ft to the edge of the traveled way.

Typical Applications

Construction	Utility work
Culvert extensions	Side slope work
Guardrail installation	Landscape work
Cleaning drainage	Structural work
Reworking ditches	Sign installation
Shoulder work	

Speed Limits (Where Existing Speed Limits are 50 mph or Higher)

- Where workers are present with channelizing devices = 45 mph.
- Where workers are present with concrete barriers = a maximum 10 mph reduction or as geometric and physical conditions dictate.
- No workers present = a maximum 10 mph reduction or as geometric and physical conditions mandate.

Speed Limits (Where Existing Speed Limits are 45 mph or Lower)

- All conditions = a maximum of 10 mph reduction or as geometric and physical conditions mandate.
- No speed reductions where existing speed limits are 30 mph or less.

A temporary traffic control order is required **prior** to starting work if speed reductions are required.

If speed reductions are used, the factors used to determine the reduced speed shall be noted in the plans.

Example Factors for Speed Reductions During Non-Work Periods or When Barrier Wall is Present

- Horizontal curvature that might increase vehicle encroachment rate (could include mainline curves, ramps, and turning roadways).

Work Zone Speed Limit Procedure

Condition 3 – Lane Encroachment

Work activities, workers, materials, and equipment that encroach the area from within 2 ft of the edge of the traveled way to 2 ft into the lane from the edge of the traveled way. Lane closures shall be required if the remaining lane is less than 10 ft in width, excluding the channelizing devices.

Typical Applications

Roadway construction
Guardrail installation
Utility work

Shoulder work

Joint work

Speed Limits (Where Existing Speed Limits are 50 mph or Higher)

- Where workers are present with channelizing devices = 45 mph.
- Where workers are present with concrete barriers = a maximum 10 mph reduction or as geometric and physical conditions dictate.
- No workers present = a maximum 10 mph reduction or as geometric and physical conditions mandate.

Speed Limits (Where Existing Speed Limits are 45 mph or Lower)

- All conditions = a maximum of 10 mph reduction or as geometric and physical conditions mandate.
- No speed reductions where existing speed limits are 30 mph or less.

No traffic control order is required.

If speed reductions are used, the factors used to determine the reduced speed shall be noted in the plans.

Factors for Speed Reductions During Non-Work Periods or When Barrier Wall is Present

- Horizontal curvature that might increase vehicle encroachment rate (could include mainline curves, ramps, or turning roadways).
- Barrier or pavement edge drop-off within 2 ft of traveled way.
- Reduction in sight distance.
- Unique or special conditions.

Work Zone Speed Limit Procedure

Condition 4 – Short Duration and Mobile Activity on Shoulder

Work activities, workers, materials, and equipment that require a short duration or mobile activity on the shoulder.

Typical Applications

Utility work Delineator installation Shoulder and slope work Landscape work

Temporary and permanent signing

Speed Limit

No reduction

Example Factors of Speed Reductions During Non-Work Periods or when Barrier Wall is Present

None

Work Zone Speed Limit Procedure

Condition 5 – Lane Activity

Work activities, workers, materials, and equipment that occur in traffic lanes.

Typical Applications

Roadway construction	Pavement resurfacing
Pavement repair	Temporary pavement marking
Utility work	Bridge repair
Widening	

Speed Limits (Where Existing Speed Limits are 50 mph or Higher)

- Where workers are present with channelizing devices = 45 mph.
- Where workers are present with concrete barriers = a maximum 10 mph reduction or as geometric and physical conditions dictate.
- No workers present = a maximum 10 mph reduction or as geometric and physical conditions mandate.

Speed Limits (Where Existing Speed Limits are 45 mph or Lower)

- All conditions = a maximum of 10 mph reduction or as geometric and physical conditions mandate.
- No speed reductions where existing speed limits are 30 mph or less

No traffic control order is required.

If speed reductions are used, the factors used to determine the reduced speed shall be noted in the plans.

Example Factors of Speed Reductions During Non-Work Periods or when Barrier Wall is Present

- Lane width reduction of 1 ft or more with a resulting lane width less than 10 ft.
- Traffic control devices encroaching on a lane open to traffic or within a closed lane, but within 2 ft of the edge of the open lane.
- Reduced posted speed for taper length or speed change lane length.
- Barrier or pavement edge drop-off within 2 ft of traveled way.
- Reduced posted speed of horizontal curve.
- Reduced posted speed for stopping sight distance.
- Traffic congestion created by lane closure.
- Unique or special conditions.

Work Zone Speed Limit Procedure

Condition 6 – Temporary Detour

Some activities require a temporary detour to be constructed. Existing routes used for detours should use established speed limits in place.

Typical Applications

Roadway construction
Sub-grade restoration
Bridge construction
Culvert repair

Speed Limits

No reduction

Example Factors of Speed Reductions During Non-Work Periods or When Barrier Wall is Present

None

Work Zone Speed Limit Procedure

Design Guideline Exceptions or Adjustments

1. For projects involving temporary traffic signals, no speed limit reductions shall be signed in advance of the temporary traffic signal. If the open traffic lane is restricted in width, signing for a reduced lane width with a speed advisory panel shall be used.

2. For projects involving traffic regulators, no speed reductions shall be signed in advance of the traffic regulator. Speed limit reductions shall be placed 100 feet beyond the end of the traffic regulator taper.

3. On longer projects, refer to the note sheets on the maintaining traffic typicals for additional speed limit sign placements.

4. Additional exceptions will be dealt with on an as needed basis through MDOT and within contract documents.

APPENDIX F

PORTABLE CHANGEABLE MESSAGE SIGN GUIDELINES

Portable Changeable Message Signs (PCMS) are used to provide motorists real-time traffic safety and advance guidance information that allows motorists to make an informed decision when approaching a work zone. This includes scheduled and unscheduled events that significantly impact traffic on the roadways.

APPLICATION GUIDELINES FOR PCMS

PCMS provide a variety of functions including:

- Ramp, lane, and road closures
- Traffic pattern changes (i.e. temporary crossovers & width restrictions)
- Moving Work Crews
- Roadwork Scheduling Advisories
- Traffic Management and alternate routing
- Warning of Adverse Road Conditions
- Traffic Operations Control
- Real-time Travel Time Messages
- Incident Management
- Safety Messages

PCMS Applications (ranked in order importance):

ADVANCE TIME NOTIFICATION

- Roadway Closures: Advance notice message, displayed 7-14 days prior to closure, addresses the temporary closure (short duration) of roadways for planned work i.e. truss or bridge beam installations.
- Ramp Closures: Displaying the message 3-7 days prior to the closure is

recommended. For freeway to freeway or weekend closures on freeways with high recreational/tourist travel, the message should be displayed longer (up to 14 days), and should include two Thursdays prior to closures. The message should include the start date/time as well as opening of the closure.

- Lane Closures: S ame as Ramp Closures.

- Planned Maintenance Work: it is recommended that the message is displayed 7-14 days prior to the planned work and include the start date/time and estimated completion date.

The message(s) displayed during the closure/work will differ from those displayed prior to the event.

EXISTING EVENTS

- Detour/Alternate Routes: The message should recommend detours/alternate routes during ramp/lane/roadway closures.

- Notice of Operations: Within unusual roadway geometrics, PCMS devices may be used as an advanced warning device in conjunction with static signing for stationary or moving operations. Hills, curves, and other unusual geometrics obstruct the view of motorists; a PCMS provides an additional notice/warning. Cancelation and completion of roadwork should also be messaged when applicable.

- Work Zone Traffic Backups: Involves monitoring congestion and backups (real- time). This is an ideal use for PCMS and requires a stopped traffic advisory system to be added to the project. Generic traffic backup messages should be avoided as this decreases the effectiveness of the stopped traffic advisory system. Programing a message during peak traffic time frames is allowed, but this message should not remain in place during off peak hours.

- Special Event Traffic Conditions: Unusual vehicle and/or non-motorized traffic patterns generated by sporting or charity events are examples for PCMS use. PCMS boards shall not be used under ANY circumstances to advertise special events. Messages for special events should be designed such that advertising is not embedded in the message. The message shall identify traffic conditions and a suggested remedy for those attending the special event and those using the same roadway to pass by the special event location.

- Real-Time, Travel Time Messages: Real-time, travel time messages are recommended to be displayed when other, higher priority messages are not available/needed. This provides useful information on current roadway conditions, providing the motorist with real-time information for informed decision making.

- Incident Management: Post roadway or lane closures due to crashes or incidents which cannot be addressed with static signing only.

- Safety Messages: If used, messages must be pre-approved by the Work Zone Business Team or a common National Work Zone approved message. Safety message should rarely be used on PCMS boards for work zones.

- Traffic Calming: LIMITED USE of messages to inform motorists of closures are permitted. Traffic calming messages indicate the reason a lane is closed (if not obvious) or when a lane will be re-opened. For example, messages notifying of an estimated opening may be displayed during the life of the closure.

PROHIBITED USE of PCMS

- Replacement of Michigan Manual of Uniform Traffic Control Devices (MMUTCD) required static signing or pavement markings.

- Advertising of any kind.

- No animation or rapid flashing symbols, pictures, or text.

- Lighted arrow replacement. (Exception: May allow static chevrons or a static arrow to provide additional direction on a detour route).

MESSAGE OBJECTIVE

PCMS boards should clearly identify what is happening within the work zone area. It should provide useful, actionable information to the motorist. Vague or generic messaging should not be used.

PCMS boards should clearly state the objective of the message by considering the following:

QUESTION	EXAMPLE MESSAGE
What is ahead?	(LEFT/RIGHT LANE CLOSED AHEAD)
How far away?	(XX MILES AHEAD)
Where?	(WOODWARD TO MOUND)
When?	(STARTS FRIDAY 8AM-9PM)
Directions advised?	(FOLLOW DETOUR)

The message should be designed to display the most important information, in as condensed a manner as possible, to meet the requirements of message timing.

PCMS MESSAGING GUIDANCE

Drivers must be able to see, read, and comprehend the message on a PCMS. It is essential that messages are clear, concise, and easily comprehended by the general public.

It is also important to properly describe the roadwork or incident location based on the expected audience. The public should believe that PCMS boards contain important, useful, and accurate information, so they read every message, every time. Providing inaccurate, confusing, non-priority messages reduces motorist interest, increasing risk factors, and ultimately leading to a loss of credibility.

PCMS must provide an 18-inch character height, with a maximum eight characters per line and three lines of text. Commuters are typically familiar with street names; however, tourists are not. Route Numbers should be used whenever possible. (Ex. M-24, US-23, I-696). When providing dates, use words for numbers whenever possible, because they are easier to read and comprehend. For example, use the format "NOV 24" instead of "11/24/11". Also, when possible, use days instead of dates for upcoming construction. "SAT-SUN" is easier to understand than "4/13 – 4/14."

FULL MATRIX LED PCMS BOARDS

NTCIP-Compliant, Full-Matrix Portable Changeable Message Boards may be used on projects as approved by each Region. Projects that may warrant the use of these pay items include locations where messages may require more than eight characters per line (with a 10-character maximum), on projects utilizing real-time travel time messages and unique messaging situations as determined appropriate.

PROHIBITED MESSAGING

The below messages do not provide the public with any guidance as it relates to an upcoming work zone and should not be used unless they meet the exceptions.

PROHIBITED MESSAGING	EXCEPTIONS
ONGOING ROAD WORK	None
DRIVE WITH CAUTION	Crash, Incident or Emergency
WATCH FOR BACKUPS	Stop Traffic Advisory and Temporary Portable Rumble Strip Projects
WORKZONE SPEED LIMIT STRICTLY ENFORCED	Project is patrolled 24/7

PCMS NOT IN USE & STORAGE

When PCMS is not needed for a message as contained in these guidelines, it must be turned off and removed from the road side, as indicated in the Standard Specifications for Construction. PCMS boards must never be turned sideways and stored on the shoulder or edge of roadway.

If during construction the message board is in an area that has limited access or may be used at a later date in the same location, 4 stars (*) may be placed in a flashing mode, with the first screen having the upper right and lower left stars (*) and the second screen having the lower right upper left stars (*). This notifies the public that the board is working, but no message is being conveyed to them.

PCMS LOCATION

PCMS should be visible from at least 1/2 mile under both daytime and nighttime conditions. Placement in advance of the work zone or incident should take into account the following factors:

- Where used for route diversion, PCMS should be placed far enough in advance to allow traffic ample opportunity to exit the affected roadway.
- PCMS are normally placed on a level shoulder of the roadway, perpendicular to traffic. If practical, placement further from the traveled lane is suggested.
- PCMS boards are typically located in remote locations, not easily accessed and far from a contractor's office. NTCIP PCMS boards are highly recommended for these areas.
- Delineate PCMS as described in the standard specifications.
- PCMS Boards must be locked at all times.
- PCMS Boards should not be located within 1000 ft. of an existing Digital Message Sign Board (DMS).
- PCMS Board locations should be detailed in construction plan sheets. When no plan sheets exist, the boards should be located by TSC staff prior to project startup.
- PCMS boards must be maintained at all times. This includes areas of dirt and dust and during the winter months, ensuring the dimming lens is free of debris, snow, and salt spray.

TEMPORARY RUMBLE STRIP PCMS PLACEMENT

PCMS boards may be used in conjunction with temporary rumble strips on a project. The boards should be placed a minimum of 500 ft. after a set of rumble strips to allow the driver time to read and comprehend the message.

STOP TRAFFIC ADVISORY PCMS PLACEMENT

PCMS boards should be placed on both sides of the roadway. Boards should be staggered approximately 1000 ft. apart to ensure the flash rate is not distracting to motorists. Depending upon the determined length of backup and the amount of PCMS boards placed on the project,

boards should be placed every 0.5-1.0 mile apart in advance of the lane closure taper.

MESSAGE TIMING

Sequencing messages are typically used when situations dictate the need for more messages than what can be displayed at one time on a PCMS. The cycle time and duration of the message is related to the operating speed of the highway. All message sequences should consist of a maximum of two messages and with a two-second minimum display time for each message. If additional sequences are needed, a second PCMS should be placed on the same side of the roadway, separated by at least 1000 ft.

INCIDENT MANAGEMENT

Incident management messaging should reference the MDOT Dynamic Message Sign Guidelines. Questions / examples of incident messaging provided below.

QUESTIONS	EXAMPLE MESSAGE
What Happened?	(CRASH)
Where?	(AT LIVERNOIS)
What is the effect?	(LEFT LANE BLOCKED)
Who is affected?	(THRU TRAFFIC)
What is advised?	(EXPECT DELAYS)

ABBREVIATIONS

Due to limitations of PCMS size or the message length, it is sometimes necessary to abbreviate words. The use of abbreviations however, should be minimized. The following are nationally recognized abbreviations for frequently used words:

STANDARD ABBREVIATIONS

WORD MESSAGE	STANDARD ABBREVIATION
Afternoon/Evening	PM
Alternate	ALT
Avenue	AVE, AV
Bicycle	BIKE
Boulevard	BLVD
Cannot	CANT
Center	CNTR
Circle	CIR
Civil Defense	CD
Court	CT
Crossing (other than highway-rail)	XING
Do Not	DON'T
Drive	DR
Emergency	EMER
Entrance, Enter	ENT
Expressway	EXPWY
Feet	FT
FM Radio	FM
Freeway	FWY
Friday	FRI
Hazardous Material	HAZMAT
Highway	HWY
Highway-Rail Grade Crossing Pavement Marking	RXR
Hospital	H
Hour(s)	HR
Information	INFO
It Is	ITS
Junction/Intersection	JCT
Lane	LN
Left	LFT
Maintenance	MAINT
Mile(s)	MI
Miles Per Hour	MPH

WORD MESSAGE	STANDARD ABBREVIATION
Minute(s)	MIN
Monday	MON
Morning/Late Night	AM
Normal	NORM
Parking	PKING
Parkway	PKWY
Pedestrian	PED
Place	PL
Pounds	LBS
Right	RHT
Road	RD
Saturday	SAT
Service	SERV
Shoulder	SHLDR
Slippery	SLIP
Speed	SPD
Street	ST
Sunday	SUN
Telephone	PHONE
Temporary	TEMP
Terrace	TER
Thursday	THURS
Traffic	TRAF
Trail	TR
Travelers	TRAVLRS
Tuesday	TUES
Two-Way Intersection	2-WAY
Two-Wheeled Vehicles	CYCLES
US Numbered Route	US
Vehicle(s)	VEH
Warning	WARN
Wednesday	WED
Will Not	WONT

ABBREVIATIONS USED WITH PROMPTS

Other abbreviations are easily understood when they appear with a prompt word commonly associated with it. The prompt word must be spelled out when used with the abbreviated word.

WORD	ABBREVIATION	PROMPT WORD
Access	ACCS	Road
Ahead	AHD	Fog*
Blocked	BLKD	Lane*
Bridge	BRDG	(Name)*
Chemical	CHEM	Spill
Condition	COND	Traffic*
Congested	CONG	Traffic*
Construction	CONST	Ahead
Downtown	DWNTN	Traffic
Exit	EXT	Next*
Express	EXP	Lane
Frontage	FRNTG	Road
Hazardous	HAZ	Driving
Interstate	I	[Number]
Local	LOC	Traffic
Major	MAJ	Accident
Minor	MNR	Accident
Minute(s)	MIN	(Number)*
Oversized	OVRSZ	Load
Pavement	PVMT	Wet*
Prepare	PREP	To Stop
Quality	QLTY	Air*
Roadwork	RDWK	Ahead [Distance]
Route	RT, RTE	Best*
Township	TWNSHP	Limits
Turnpike	TRNPK	(Name)*
Cardinal Directions	NB, EB, SB, WB	(Number)
Upper, Lower	UPR, LWR	Level
Work	WRK	Road*

* = Prompt word given first

Abbreviations should be used cautiously with prompt words as they can cause confusion when used in the wrong context. For example, drivers interpret BLKD as BLOCKED when it appears with LANE in the form LANE BLKD. CHEM is interpreted by drivers as CHEMICAL when used in the message as CHEM SPILL. The table below provides a list of abbreviations that are easily misinterpreted.

UNACCEPTABLE ABBREVIATIONS

ABBREVIATION	INTENDED WORD	COMMON MISINTERPRETATIONS
ACC	Accident	Access (Road)
CLRS	Clears	Colors
DLY	Delay	Daily
FDR	Feeder	Federal
L	Left	Lane (Merge)
LT	Light (Traffic)	Left
PARK	Parking	Park
POLL	Pollution (Index)	Poll
RED	Reduce	Red
STAD	Stadium	Standard
WRNG	Warning	Wrong

SAMPLE MESSAGING

STANDARD MESSAGES

RIGHT(LEFT) LANE CLOSED	XX MILES AHEAD
TRAFFIC SHIFT RIGHT(LEFT)	XX MILES AHEAD
RD WORK US-24 TO M-39	RIGHT(LEFT) LN CLOSED AHEAD
NEW TRAFFIC PATTERN	XX MILES AHEAD
ROAD WORK AHEAD	8 MILE TO 9 MILE
RD WORK US-24 TO ECORSE	TRUCKS USE LEFT(RIGHT) LANE
NARROW LANES AHEAD	REDUCE SPEED
NARROW LANES AHEAD	OVERSIZE LOADS EXIT XXX
RD WORK AT LAPEER	STARTING APRIL 5TH
RD WORK M-24 TO M-15	BEGINS APRIL 5TH
NIGHTLY LANE CLOSURES	9PM TO 5AM

STOP TRAFFIC ADVISORY SYSTEM

SLOW TRAFFIC AHEAD	WATCH FOR BACKUPS
STOPPED TRAFFIC AHEAD	BE PREPARED TO STOP
SLOWED TRAFFIC	XX MILES AHEAD
STOPPED TRAFFIC	XX MILES AHEAD
RD WORK XX MILES AHEAD	TRUCKS USE LEFT(RIGHT) LANE
RD WORK US-24 TO M-39	MOTRCYCLS USE LEFT(RIGHT) LANE

RUMBLE STRIPS

RUMBLE STRIPS AHEAD	ATTENTION MOTOR- CYCLES
RUMBLE STRIPS	XX MILES AHEAD
RUMBLE STRIPS AHEAD	REDUCE SPEED

DETOURS

HAMBURG ROAD CLOSED	FOLLOW DETOUR
HAMBURG ROAD CLOSED	USE EXIT XXX
WB I-94 TRAFFIC	USE 8 MILE RD
WB I-94 CLOSED	FOLLOW DETOUR
US-24 RAMP CLOSED	USE EXIT XXX
US-24 RAMP CLOSED	FOLLOW DETOUR

FREEWAY STOPPAGES

15 MIN CLOSURES	STARTING MON 9PM TO 5AM
15 MIN FWY CLOSURES	SEEK ALT ROUTE
NIGHTLY FWY CLOSURES	MON-FRI 9PM TO 5AM

APPENDIX G

RESOURCE LINKS

For research purposes, the following web sites have information specifically related to work zone operations or organizations and programs that address work zone safety and mobility issues.

MDOT

- MDOT Mobility Map
  http://featuredmaps-mdot.opendata.arcgis.com/app/mobility-restrictions-map

- Work Zone Home Page
  www.michigan.gov/mdotworkzones

- MDOT Manuals and Guides
  http://www.michigan.gov/mdot/0,4616,7-151-9622_11044_11367---,00.html

- MDOT Specifications for Construction
  https://mdotjboss.state.mi.us/SpecProv/specBookHome.htm

- MDOT Standard Plans
  https://mdotjboss.state.mi.us/stdplan/standardPlansHome.htm

- Frequently Used Special Provisions
  https://mdotcf.state.mi.us/public/dessssp/spss/

- Previously approved Special Provisions
  https://mdotjboss.state.mi.us/SpecProv/specProvHome.htm

FHWA

- FHWA Work Zone Operations Best Practice Guidebook
  http://ops.fhwa.dot.gov/wz/practices/practices.htm

- FHWA
  www.fhwa.dot.govhttp://www.ops.fhwa.dot.gov/wz/index.asp

- FHWA Highway Rail/Grade Crossing
  http://safety.fhwa.dot.gov/xings/

- FHWA MUTCD web site
  http://mutcd.fhwa.dot.gov

- Work Zone Safety Information Clearinghouse
  www.workzonesafety.org

- Countermeasures that Reduce Crash Severity
  https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/

- Work Zone Process Review Toolbox
  https://ops.fhwa.dot.gov/wz/prtoolbox/pr_toolbox.htm

MIOSHA

- Department of licensing and Regulatory Affairs
  http://www.michigan.gov/lara/0,4601,7-154-11407---,00.html

- Part 22
  http://www.michigan.gov/documents/lara/lara_miosha_CS_22_419359_7.pdf

Other Resources

- American Road and Transportation Builders Association
  www.artba.org

- American Traffic Safety Services Association
  www.atssa.com

- American General Contractors
  www.agc.org

- American Association of State Highway and Transportation Officials
  http://www.transportation.org

- Synthesis of Intelligent Work Zone Practices
  http://www.enterprise.prog.org/Projects/2010_Present/iwz.html?EventID=1433072641&FirstName=chris&LastName=brookes&Email=brookesc%40michigan.gov&EnrollmentID=

- Institute of Transportation Engineers
  http://www.ite.org

Local Transportation Assistance Program
- http://www.ltap.org

- National Utilities Contractors Association
  http://www.nuca.com

APPENDIX H

TRAFFIC REGULATOR ZONES

CAPACITY IN TRAFFIC REGULATOR ZONES			
LENGTH OF TRAFFIC REGULATOR ZONE MILES (KILOMETERS)	35 MPH POSTED CONSTRUCTION ZONE SPEED	45 MPH POSTED CONSTRUCTION ZONE SPEED	55 MPH POSTED CONSTRUCTION ZONE SPEED
	CAPACITY (VPH)	CAPACITY (VPH)	CAPACITY (VPH)
0.1 (0.16)	1158	1163	1166
0.2 (0.32)	1136	1146	1152
0.3 (0.48)	1112	1128	1138
0.4 (0.64)	1088	1110	1123
0.5 (0.80)	1063	1091	1108
0.6 (0.96)	1037	1072	1093
0.7 (1.12)	1010	1052	1077
0.8 (1.28)	982	1031	1061
0.9 (1.45)	953	1010	1044
1.0 (1.61)	922	988	1027
1.1 (1.77)	890	966	1010
1.2 (1.93)	857	943	992
1.3 (2.10)	822	919	974
1.4 (2.25)	786	894	955
1.5 (2.41)	748	868	936
1.6 (2.57)	708	842	916
1.7 (2.74)	666	814	896
1.8 (2.89)	622	786	875
1.9 (3.05)	575	756	854
2.0 (3.22)	526	726	832
2.1 (3.38)	475	694	809
2.2 (3.54)	420	661	786
2.3 (3.70)	363	627	762
2.4 (3.86)	302	591	737
2.5 (4.02)	237	554	711

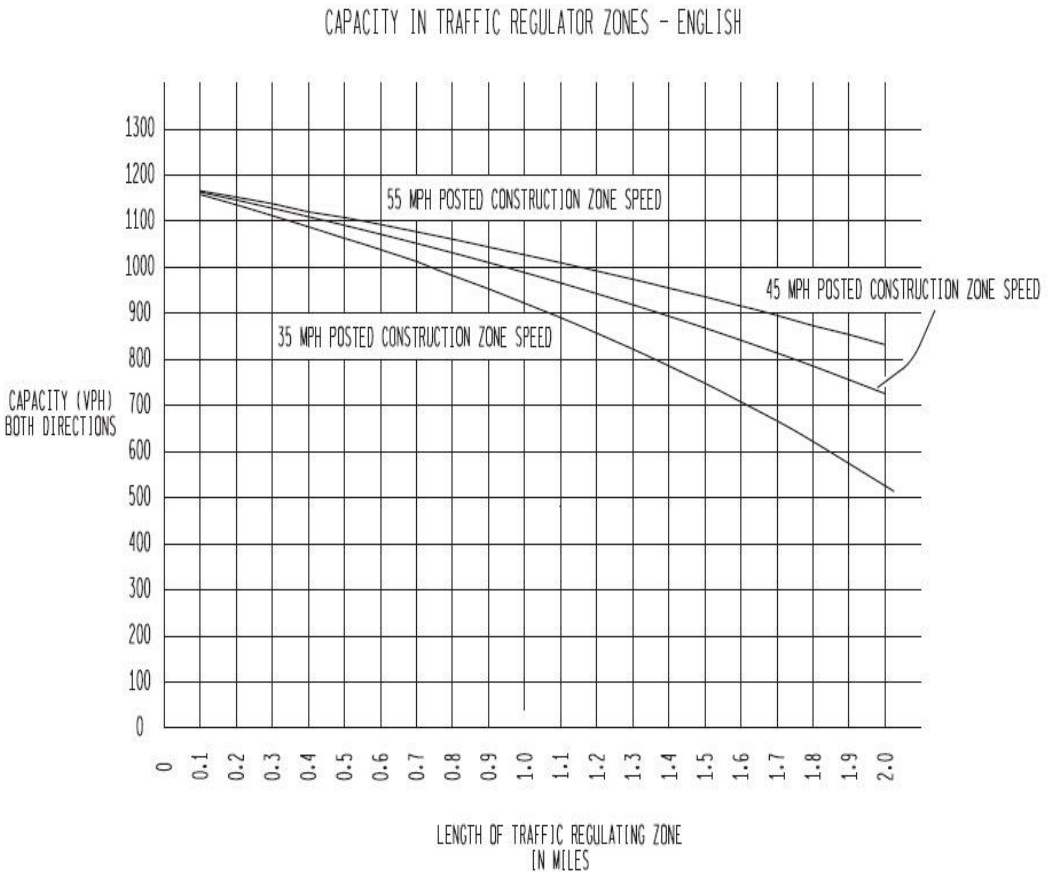
MDOT Michigan Department of Transportation

TRAFFIC AND SAFETY NOTE

CAPACITY IN TRAFFIC REGULATING ZONES

DRAWN BY: DFK
CHECKED BY: JAT
PLAN DATE: 11/14/06
Note 908A
SHEET 2 OF 4

FILE: Pw RD TS T Dev Note908A tsn.dgn
REV. 11/14/2006



MDOT Michigan Department of Transportation

TRAFFIC AND SAFETY NOTE

CAPACITY IN TRAFFIC REGULATING ZONES

DRAWN BY: DFK
CHECKED BY: JAT
FILE: PW RD TS T Dev Note908A tsr.dgn

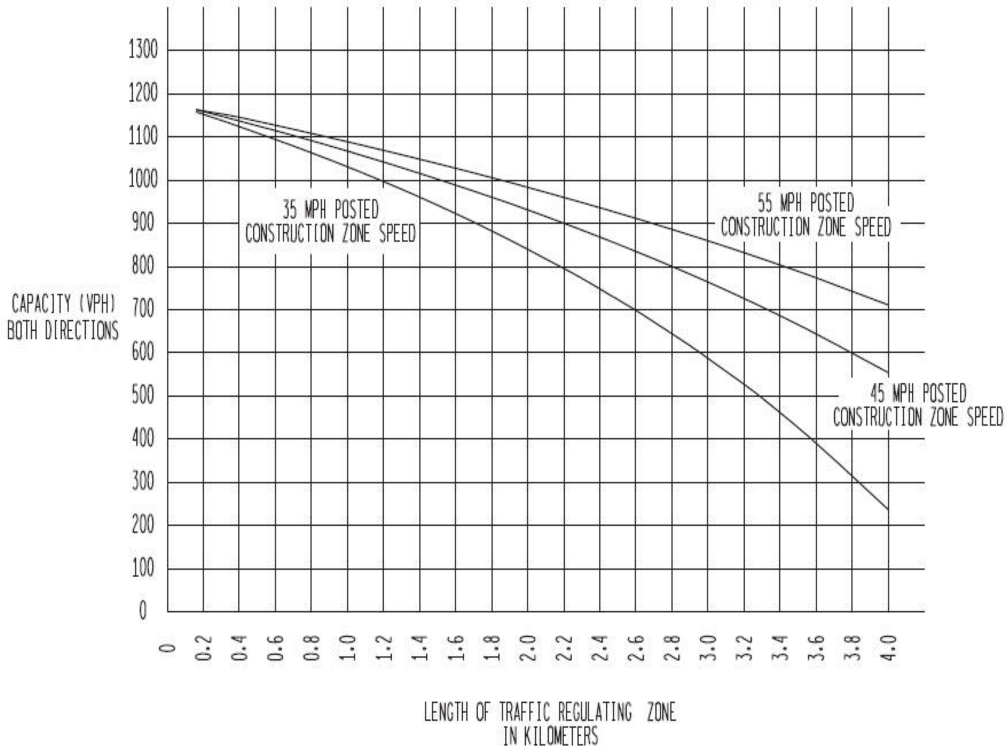
11/14/06
PLAN DATE:

Note 908A

SHEET 3 OF 4

REV. 11/14/2006

CAPACITY IN TRAFFIC REGULATOR ZONES – METRIC



MDOT Michigan Department of Transportation

TRAFFIC AND SAFETY NOTE

DRAWN BY: DFK
CHECKED BY: JAT
FILE:PW RD TS T Dev Note908A tsn.dgn

CAPACITY IN TRAFFIC REGULATING ZONES

PLAN DATE: 11/14/06

Note 908A

REV.11/14/2006

SHEET 4 OF 4

APPENDIX I

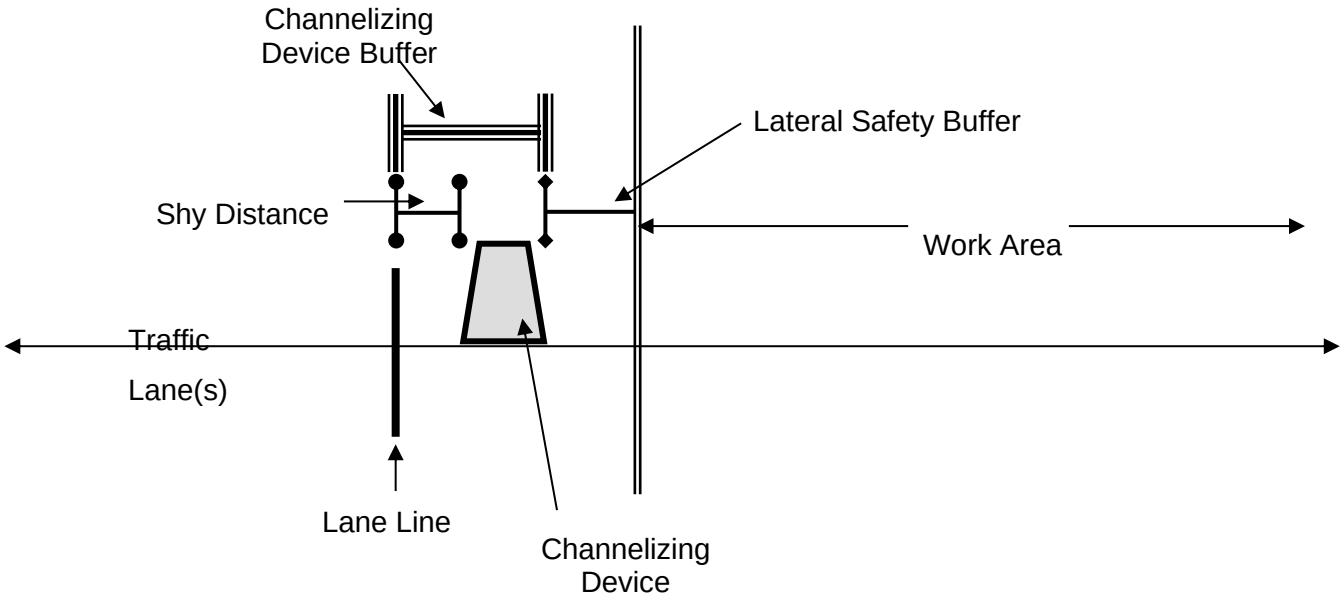
LCCA MAINTENANCE OF TRAFFIC FLOWCHARTS

(Added 1/20/2020)

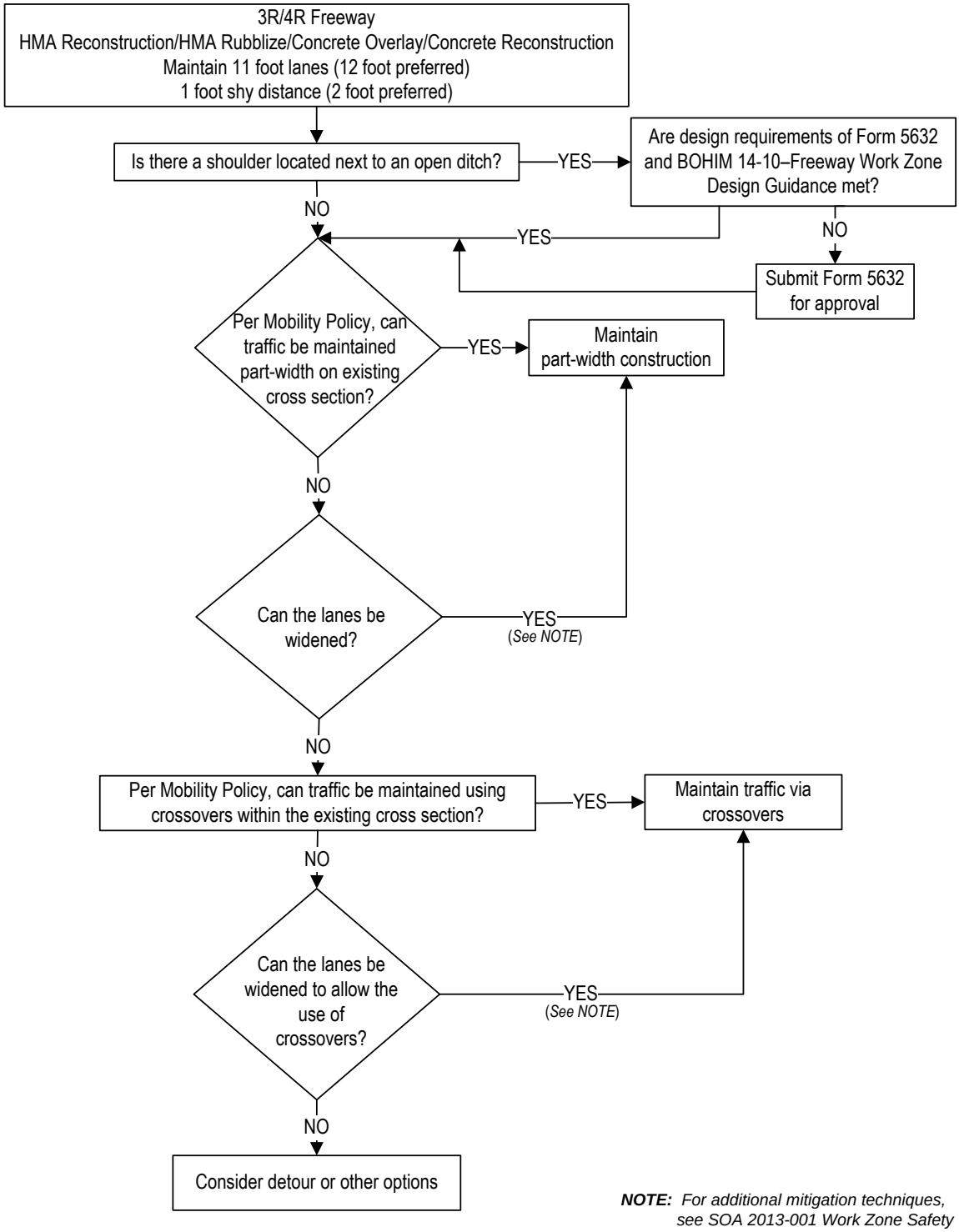
The following flowcharts provide guidelines for maintaining traffic and are to be utilized with projects requiring an LCCA. A Nomenclature diagram is provided to assist in defining some terminology found in the flowcharts.

NOMENCLATURE

(not to scale)



Maintaining Traffic for Freeways

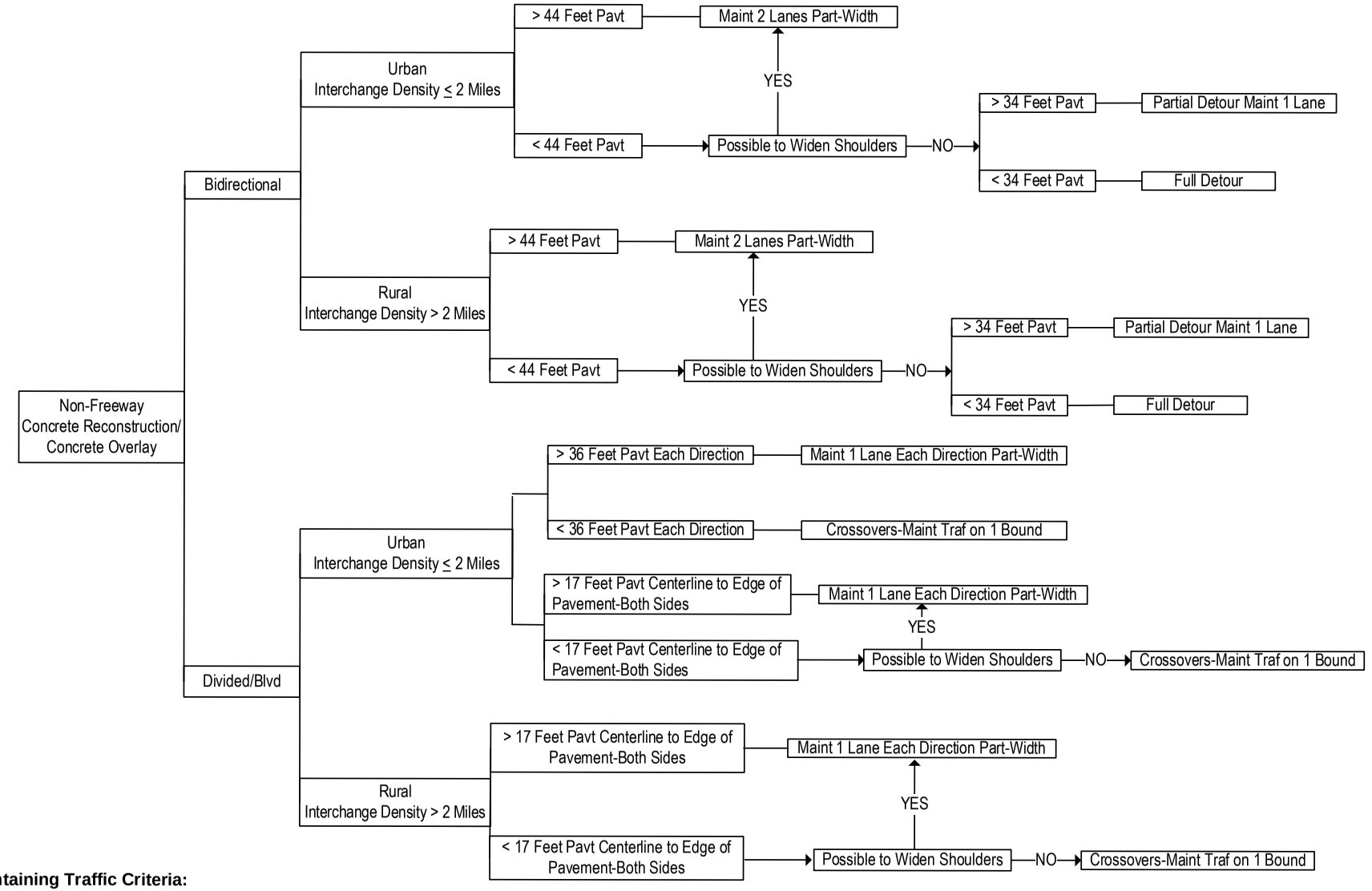


NOTE: *For additional mitigation techniques, see SOA 2013-001 Work Zone Safety Tools for Narrow Shoulders*

Maintaining Traffic Criteria:

1) Traffic will be maintained on a minimum of 11 foot wide lanes.
2) Maintain four-foot wide channelizing device buffer, which includes a minimum of 1 foot of shy distance from the edge of the travel lanes to channelizing devices plus the width of the channelizing devices.
3) Refer to the Work Zone Safety and Mobility Manual for guidance on edge drop protection requirements based on drop off.
4) Construction joints will match lane lines (longitudinal paint lines).
5) Maintain a 4-foot wide lateral safety buffer. For HMA rubblize with ADT < 20,000, this lateral safety buffer shall be a minimum of 1 foot.

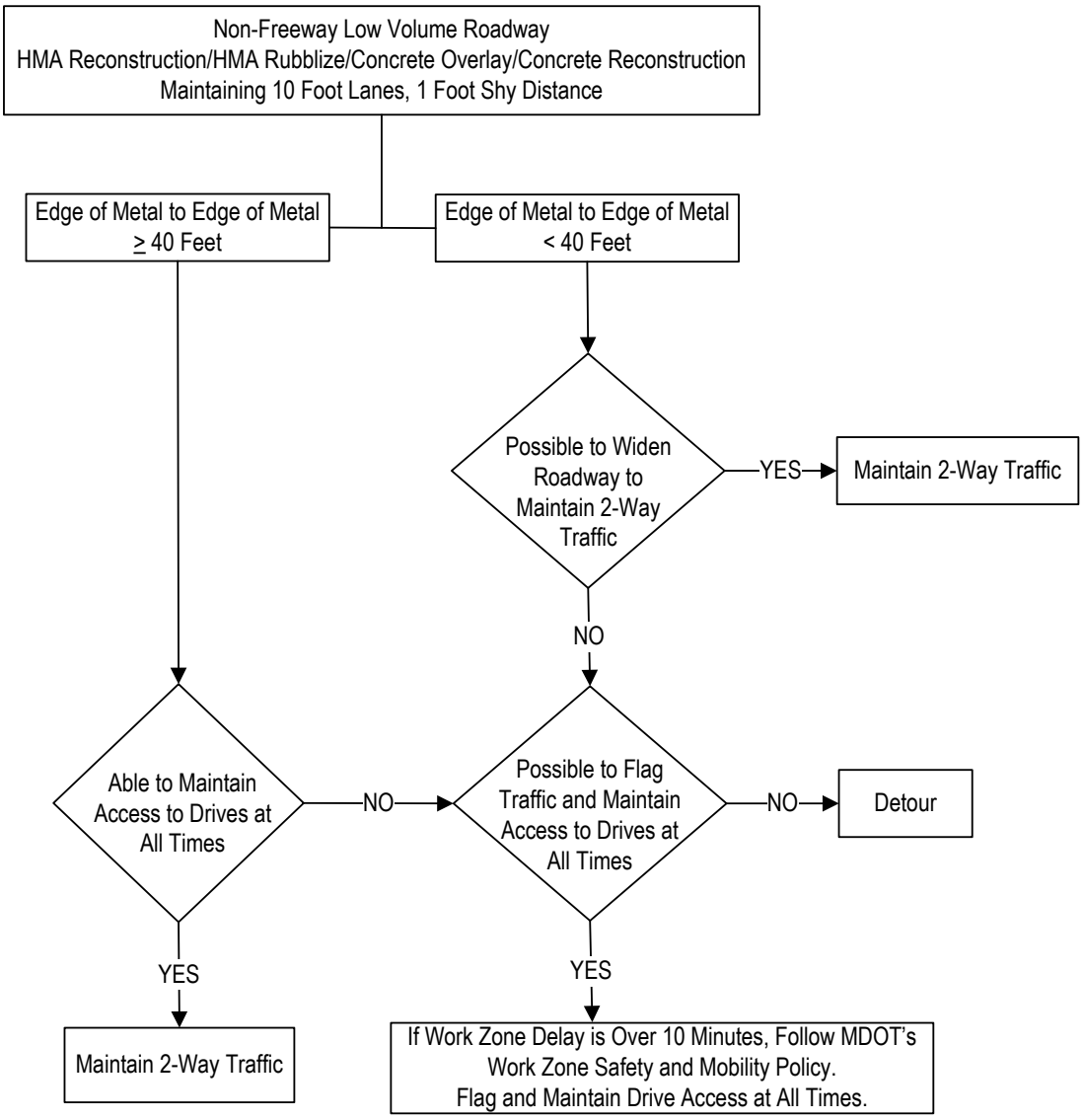
Maintaining Traffic for Non-Freeway Concrete Reconstruction/Concrete Overlay



Maintaining Traffic Criteria:

1) Traffic will be maintained on 11-foot wide lanes and 1-foot shy distance.
2) Maintain 4-foot wide channelizing device buffer, which includes a minimum of 1 foot of shy distance from the edge of the travel lanes to channelizing devices plus the width of the channelizing devices.
3) Refer to the Work Zone Safety and Mobility Manual for guidance on edge drop protection requirements based on drop off.
4) Construction joints will match lane lines.
5) Maintain lateral safety buffer of 4 feet minimum.

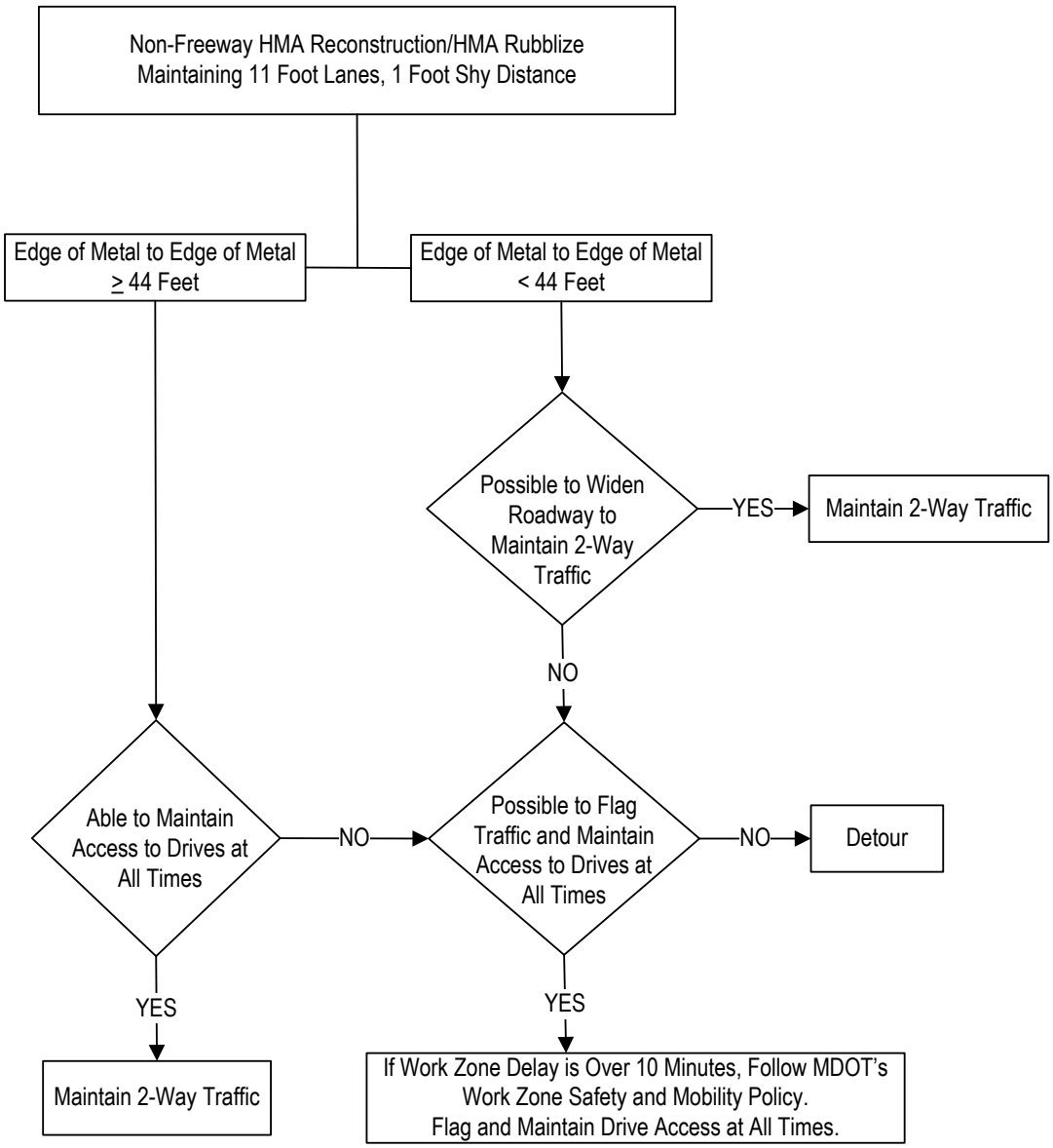
Maintaining Traffic for Non-Freeway Low Volume Roadway (< 20,000 ADT)
HMA Reconstruction/HMA Rubblize/Concrete Overlay/Concrete Reconstruction



Maintaining Traffic Criteria:

1) Traffic will be maintained on a minimum of 10 foot wide lanes.
2) Maintain a 4-foot wide channelizing device buffer, which includes a minimum of 1 foot of shy distance from the edge of the travel lanes to channelizing devices plus the width of the channelizing devices.
3) Refer to the Work Zone Safety and Mobility Manual for guidance on edge drop protection requirements based on drop off.
4) Construction joints will match lane lines (longitudinal paint lines).
5) Maintain a 4-foot wide lateral safety buffer. For HMA rubblize, this lateral safety buffer shall be a minimum of 1 foot.

Maintaining Traffic for Non-Freeway HMA Reconstruction/HMA Rubblize



Maintaining Traffic Criteria:

1) Traffic will be maintained on 11 foot wide lanes.
2) Maintain four-foot wide channelizing device buffer, which includes a minimum of 1 foot of shy distance from the edge of the travel lanes to channelizing devices plus the width of the channelizing devices.
3) Refer to the Work Zone Safety and Mobility Manual for guidance on edge drop protection requirements based on drop off.
4) Construction joints will match lane lines (longitudinal paint lines).
5) Maintain a 4-foot wide lateral safety buffer.